MEMOIRS OF THE HOURGLASS CRUISES

Published by
Marine Research Laboratory
Florida Department of Natural Resources
St. Petersburg, Florida

VOLUME I | JUNE 1970 | PART IV

SCYLLARID LOBSTERS (CRUSTACEA, DECAPODA)

By

WILLIAM G. LYONS

ABSTRACT

Five species of scyllarid lobsters were captured in a 28 month systematic sampling program on the west Florida shelf. *Scyllarides nodifer* and *Scyllarus chacei* were often captured, *S. americanus* and *S. depressus* were less abundant, and *Scyllarides aequinoctialis* was found only once. Although *Scyllarus faxoni* has not yet been reported from the Gulf of Mexico, it probably occurs there but little sampling has been conducted within its depth range of 229-457 m.

Scyllarides nodifer occurs from the Gulf of Mexico to North Carolina and Bermuda in 2 to 91 m. The Florida Current and Gulf Stream probably prohibit distribution of the larvae southward. *S. aequinoctialis* occurs throughout the Caribbean and northward to Bermuda, but only rarely in the Gulf of Mexico. *Scyllarus americanus* is now known from the Gulf of Venezuela to North Carolina in 0 to 46 m and is common at some inshore locations off west Florida. *S. chacei*, abundant in samples from this program, ranges from Brazil to North Carolina in 11 to 320 m. Adult *S. depressus* are known from southern Brazil to North Carolina in 29 to 265 m; postlarvae occasionally occur farther north.

Scyllarus depressus (Smith 1881) replaces *S. nearctus* Holthuis as the valid name for that species. The type of *S. depressus* is a postlarva dredged off Martha's Vineyard, where its occurrence is considered adventitious. Postlarvae of this species are much larger than those of *S. americanus* and

Contribution No. 144

Effective July 1, 1969, agencies of the State of Florida underwent legislative reorganization and the Florida Board of Conservation was renamed the Florida Department of Natural Resources. Similarly, the former Division of Salt Water Fisheries became the Division of Marine Resources.

Accepted for publication January 1970.

S. chacei. Postlarvae of the latter two species may be separated by setation counts of the first pleopod. *Pseudibacus gerstaeckeri* is correctly assigned as the postlarva of *Scyllarides aequinoctialis.* Early juveniles of this species are unknown. Postlarvae of *S. nodifer* are smaller than those of *S. aequinoctialis* and strongly resemble their early juvenile stages.

Fertilization in *Scyllarides* and *Scyllarus* is apparently internal. Spawning of *Scyllarides nodifer* is restricted to late May through early August with a larval period of eight to nine months. *Scyllarus americanus, S. chacei,* and *S. depressus* spawn throughout the year, most heavily during spring and early summer; juveniles are similar to adults in relative morphometry. Young *Scyllarides nodifer* have carapace widths greater than carapace lengths, a condition reversed in adults.

Epizooic commensals and predators of western Atlantic scyllarids are noted and discussed.

Scyllarides nodifer entered three types of wood and wire traps used in an exploratory fishing program. A trapping fishery for this species offshore from Tampa Bay does not appear economically feasible, but results indicate that catches might be better off Ft. Myers and farther south.

INTRODUCTION

In the spring and summer of 1965, the Bureau of Commercial Fisheries of the U. S. Fish and Wildlife Service and the Florida Board of Conservation (Department of Natural Resources) participated in a cooperative exploratory fishing program in the eastern Gulf of Mexico to locate populations of commercial fishes and to test equipment which could be utilized aboard a shrimp vessel such as the R/V *Hernan Cortez.* In the course of this program, a number of scyllaridean lobsters, notably *Scyllarides nodifer* (Stimpson), were captured. This success and consideration of reports from commercial shrimp fishermen who had occasionally landed substantial quantities of *S. nodifer* from waters off the Florida west coast prompted our Laboratory to initiate a project in March 1966 to determine commercial potential of these lobsters. The project, designed to determine size frequencies, spawning periods, preferred bottom types, geographic and bathymetric distributions, and availability to various types of traps and trawls was incorporated into the Hourglass program.

Three species of *Scyllarus* were also obtained. Although these lobsters may be too small to be of any importance in the present commercial fishery, it was decided that they too should be studied to develop a better understanding of the entire group. Future use for food, bait, or other purposes is possible. Information on predation and commensal relationships was also obtained through analysis of collection data. Occurrence of postlarvae and juvenile scyllarideans in the catch has allowed speculation concerning early life history of the species collected.

ACKNOWLEDGMENTS

Many staff members of the Florida Department of Natural Resources contributed in various ways to the completion of this study and to them I offer my sincere thanks. I am particularly grateful to Dr. Philip B. Robertson, Woods Hole Oceanographic Institute, for permitting me to cite

some of the previously unpublished information contained in his dissertation, for providing specimens from Biscayne Bay, and for helpful suggestions concerning this investigation. Dr. A. J. Provenzano, Jr., Institute of Marine and Atmospheric Sciences, Miami, Florida, provided specimens, suggestions, and encouragement. Dr. R. B. Manning kindly arranged access to specimens at the U. S. National Museum, Washington, D.C. Dr. L. B. Holthuis, Rijksmuseum van Natuurlijke Historie, Leiden, Netherlands, graciously suggested answers to several perplexing problems. Mr. C. E. Cutress, University of Puerto Rico, Mayaguez, loaned specimens and provided information concerning species there. Dr. J. A. Baisre, Instituto de Oceanologia, Habana, Cuba, Mr. H. R. Bullis, Jr., Bureau of Commercial Fisheries, Pascagoula, Mississippi, Dr. A. E. Dammann, Caribbean Research Institute, St. John, Virgin Islands, Dr. D. S. Erdman, Fish and Wildlife Division, Puerto Rico Department of Agriculture, San Juan, and Dr. W. F. Rathjen, UNSF/FAO Caribbean Fisheries Development Project, Bridgetown, Barbados, all graciously provided information about scyllarideans from their investigations. Dr. Dora Henry, University of Washington, Seattle, Washington, identified the balanoid and octolasmid barnacles. Mr. Robert Lipe, St. Petersburg, Florida donated specimens and color slides of *Scyllarides nodifer* from the Florida Keys. Finally, I am especially grateful to Miss Robin Ingle for preparing the drawings of *Scyllarides*.

METHODS AND MATERIALS

Many of the lobsters examined were contained in the Hourglass collections. These collections were taken monthly by trawling and dredging at ten stations offshore from Tampa Bay and Sanibel Island, Florida, in depths of 3.3, 10, 20, 30, and 40 fathoms (6, 18, 37, 55, and 73 meters) (Joyce and Williams, 1969). Consistent with the increasing usage of metric units, all depths have been converted to whole meters throughout this report. The Hourglass cruise pattern is shown in Figure 1.

Review of pertinent literature, examination of other specimens in our invertebrate reference collection (FSBC) and at the U. S. National Museum (USNM), and correspondence with other workers provided additional distribution records. Depths, geographic coordinates, bottom types, salinities, and temperatures were noted when available.

Exploratory trapping and trawling were conducted monthly beginning in March 1966. These collections were incorporated into the Post-Hourglass phase of the Hourglass program and were limited by the demands of the program to the Tampa Bay-Sanibel Island area. After the daylight stations were sampled, the vessel proceeded to a preselected area chosen for depth and bottom type. Traps were set upon arrival and pulled in the late afternoon and early morning. At least two traps of each of three styles were used in a set. A variety of fish and mollusks were used as bait, all with some degree of success.

Square and angled wood traps, and wire traps were used throughout the program. Wood traps were constructed of 3/8 by 1 1/2 inch laths spaced 1 1/2 inches apart and nailed to a frame of 3/4 by 1 1/2 inch pine. The traps were ballasted with cement. Outside dimensions were: square traps – length, 33 inches; width, 24 inches; height, 13 inches; angled traps – length, 24 inches; bottom width, 31 inches; top width, 9 inches; height, 14 inches. Funnels for both types, also constructed of wood laths, were square and measured 7 inches along a side. Wire traps were constructed of 1 inch by 2 inch rectangular galvanized screen. When viewed from above, the trap outline resembled a heart. A gently sloping ramp extended upward from the bottom of the trap to the circular funnel

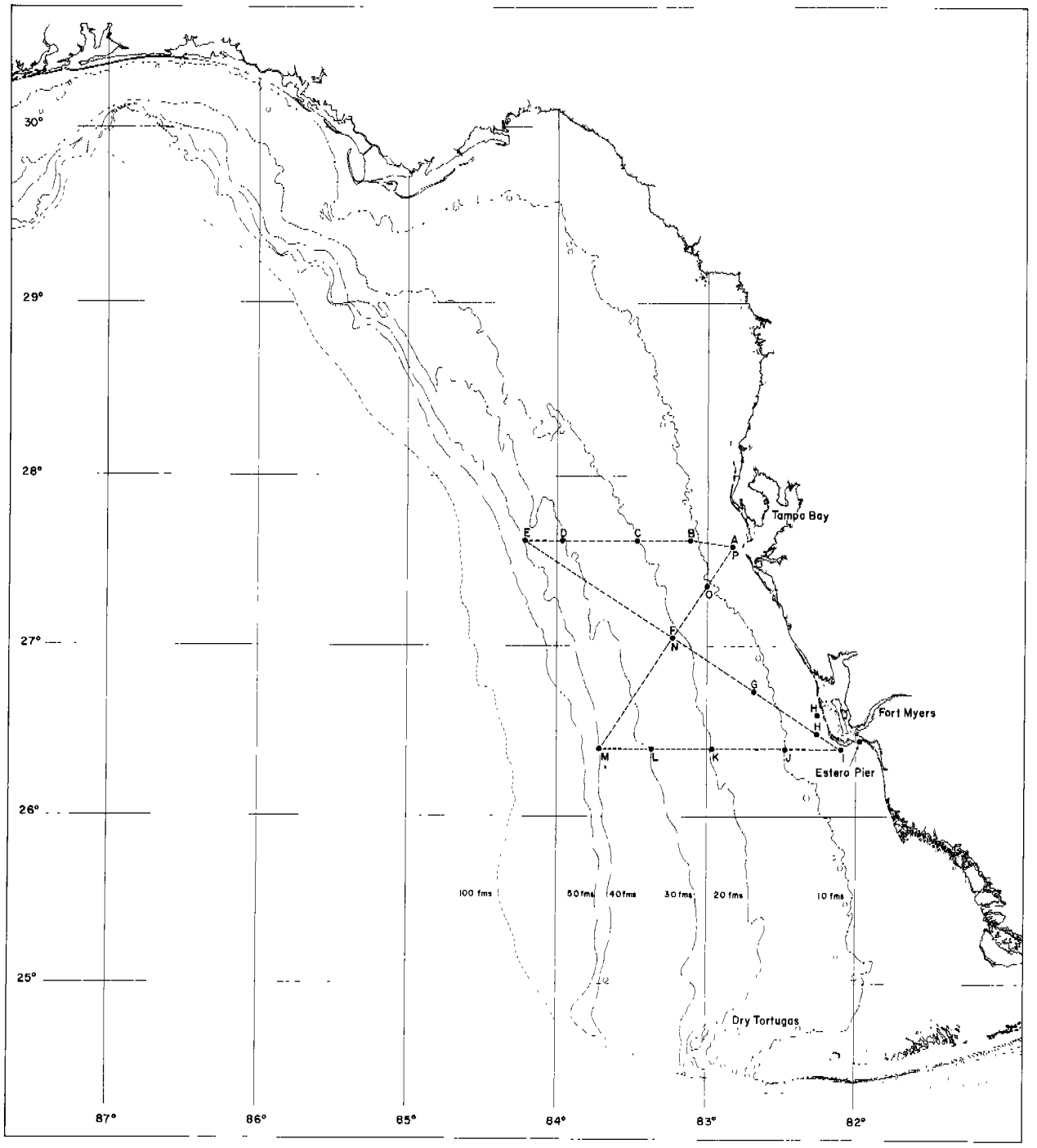


Figure 1. Hourglass cruise pattern and station locations.

located in the middle of the concave section of the "heart." Funnel diameter was 7 inches. Other dimensions were: length, 50 inches; greatest width, 48 inches; height, 24 inches. Wire traps were negatively buoyant and were not otherwise weighted. All traps were buoyed with styrofoam floats or sealed plastic jugs attached to polyethylene rope. Baits were suspended within the traps with cotton twine.

Measurements of the animals include:

1) Carapace length (CL), measured from the center of the line dividing the orbits to the center of the posterior margin of the carapace. Large specimens were measured with vernier calipers, smaller specimens with fine-point dividers marked off on a millimeter scale. All measurements are to the nearest 0.1 mm.

2) Carapace width (CW), measured as the distance between the spines at the anterolateral margin of the carapace. Vernier calipers were used for the large specimens, fine-point dividers for the smaller ones. Measurements are to the nearest 0.1 mm.

3) Total length (TL) was measured from the line dividing the orbits to the posterior margin of the telson. As the abdomen is usually folded beneath itself in preserved material, the specimens were extended on a flat surface and pressure was applied in the region of the third abdominal somite to insure maximum extension of the animal without stretching. Large *Scyllarides nodifer* were measured with outside-style spring calipers and marked off on a millimeter scale. Measurements were made to the nearest 1.0 mm. Adult *Scyllarus* and *Scyllarides* of comparable size were measured with vernier calipers. Postlarvae and early juvenile *Scyllarides* and *Scyllarus* were measured with fine-point dividers and marked off on a millimeter scale. Vernier caliper and divider figures are to the nearest 0.1 mm.

4) Weight (WT), measured in grams, was determined for small *Scyllarides* and all *Scyllarus* on a Welch triple-beam balance with an accuracy of $\pm$ 0.01g. Larger (over 100.0 g) *S. nodifer* were measured on an Ohaus Harvard trip balance. All measurements were to the nearest 0.01 g.

Logarithmic curves representing length-weight relationships were calculated from the equation

$$\text{Log } W = \text{Log } a + n\text{Log } L$$

$$\text{where Log } a = \frac{\Sigma\text{Log } W \cdot \Sigma(\text{Log } L)^2 - \Sigma\text{Log } L \cdot \Sigma(\text{Log } L \cdot \text{Log } W)}{N \cdot \Sigma(\text{Log } L)^2 - (\Sigma\text{Log } L)^2}$$

$$n = \frac{\Sigma\text{Log } W - (N \cdot \text{Log } a)}{\Sigma\text{Log } L}$$

W=weight, and L=length.

Average carapace lengths were computed from empirical data for various numbers of size groups (N). N is dependent upon the size range of each species and sometimes varied between sexes in the same species. Carapace length was preferred to total length because more margin for error is involved in the latter, which, in a sense, is dependent upon the amount of pressure exerted upon the abdomen. Unless otherwise noted, all lengths are carapace lengths.

Size frequencies of carapace lengths and weights were plotted for two species to demonstrate sexual dimorphism. Sex of all lobsters which had developed sufficiently was determined by presence of the genital duct at the base of the third leg in females and at the base of the fifth leg in males. Spawning periods were deduced by noting gravid females in the catch.

Six areas of each scyllarid postlarval pleopod have plumose setae. Counts of these setae were used to aid in species determination. These areas have been designated pleopod areas I through VI (Figure 2).

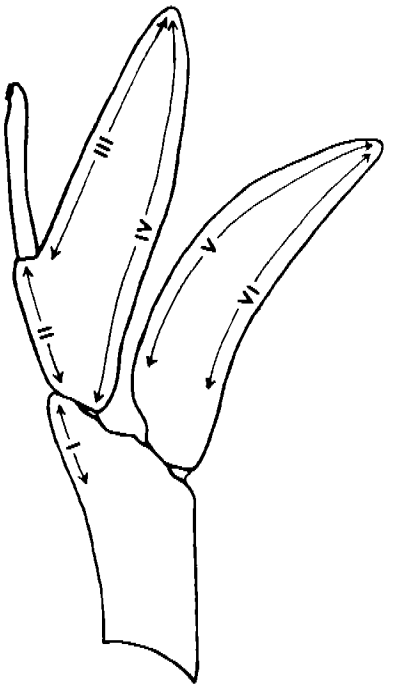


Figure 2. Typical scyllarid pleopod, showing setation areas I – VI.

SYSTEMATICS

Twelve species of scyllarid lobsters are now known to occur in the western Atlantic. *Scyllarides braziliensis* Rathbun, *S. delfosi* Holthuis, and *S. deceptor* Holthuis are apparently restricted to South American waters, *Scyllarus planorbis* Holthuis occurs offshore from Honduras to Venezuela, and *Arctides guineensis* (Spengler) has been captured only in the Bahamas and at Bermuda. *Parribacus antarcticus* (Lund) occurs throughout the Caribbean region and is occasionally captured in the Florida Keys (Schroeder, 1965; Schroeder and Starck, 1964), but has not been recorded from the Gulf of Mexico. Since this species is usually captured in association with more tropical coral reefs, it probably will not be found in the eastern Gulf of Mexico but may occur in the southwestern Gulf off the Yucatan peninsula where such conditions prevail. *Scyllarus faxoni* Bouvier occurs in depths ranging from 228 to 457 meters throughout the Caribbean. Its exclusion from the reported Gulf of Mexico fauna is probably due to insufficient collecting. Since it may later be found here, it has been included in this report.

Scyllarides nodifer (Stimpson), *Scyllarus americanus* (Smith), *S. chacei* Holthuis, and *S. depressus* (Smith) were taken regularly in Hourglass collections. All appear reasonably common in the eastern Gulf on suitable bottom within their respective bathymetric ranges.

Scyllarides aequinoctialis (Lund) has much the same range as *Parribacus antarcticus* and has been reported throughout the Caribbean region, in the Florida Keys, and at Bermuda, being generally taken from a reef environment. It has also been reported from off Texas in the Gulf of Mexico (Hildebrand, 1954), and occurs occasionally in the catch of commercial shrimpers working the Tortugas grounds in the extreme southeastern Gulf (Mrs. Bonnie Eldred, personal communication). One postlarva of this species was taken in an Hourglass collection. This species is evidently quite rare in the eastern Gulf.

KEY TO THE GENERA AND SPECIES OF SCYLLARIDAE IN THE GULF OF MEXICO

(Modified from Williams, 1965)

1. Exognath of outer maxillipeds without a flagellum; terminal article of antennae with edge cut into deep lobes distally . . . . . *Scyllarus*

   2. Prominent midventral tubercle on each of the five sternal plates; posterior margin of fifth abdominal segment with a large median spine . . . . . *Scyllarus faxoni*

   2' Midventral tubercle or elevation on fifth sternal plate only; posterior margin of fifth abdominal segment nearly straight, without a median spine 3

      3. Gastric and all lateral prominences on carapace sharp; second article of antennular peduncles cylindrical; pleura of fourth abdominal segment sharply rectangular or acute laterally . . . . . *Scyllarus depressus*

      3' Prominences on carapace blunt; second article of antennular peduncles flattened dorsally; pleura of fourth abdominal segment rounded laterally 4

         4. Pregastric tooth of carapace nearly always bilobed, incised; first to fourth abdominal segments with a deep, narrow median notch in posterior margin. . . . . *Scyllarus americanus*

         4.' Pregastric tooth of carapace rounded, entire; first to fourth abdominal segments with a very shallow, broad median notch in posterior margin . . . . . *Scyllarus chacei*

1' Exogath of outer maxillipeds with a flagellum; terminal article of antennae with edge nearly smooth or crenulate distally . . . . . *Scyllarides*

   2. Gastric, cardiac, and branchial regions of carapace elevated, distinct; pregastric and gastric teeth prominent in profile; second through fourth abdominal segments with a median, node-like carina . . . . . *Scyllarides nodifer*

   2' Gastric, cardiac, and branchial regions of carapace low, not strongly defined; pregastric and gastric teeth not obvious in profile; second through fourth abdominal segments low, rounded, without distinct carina . . . . . *Scyllarides aequinoctialis*

Scyllarides nodifer (Stimpson)

Figure 3; Plate 1, Figures A, B

Scyllarus nodifer Stimpson, 1866, p. 48, 1871, p. 123; Butler & Pease, 1965, p. 24.

Scyllarus latus von Martens, 1872, p. 122 (not Latreille, 1803).

Scyllarides americanus Verrill, 1922, p. 24, pls. 5-6; Holthuis, 1959, p. 127 (in part).

Scyllarides nodifer Springer & Bullis, 1956, p. 14; Holthuis, 1960, p. 123; Williams, 1965, p. 98-99, fig. 77; Bullis & Thompson, 1965, p. 9; Robertson, 1968a, p. 161.

Diagnosis. Carapace broadest at anterolateral spines; gastric, cardiac, and branchial regions elevated, distinct; pregastric and gastric teeth prominent in profile; second through fourth abdominal segments with a median, node-like carina, most evident on fourth; usually three large spots on upper surface of first abdominal segment; carapace and abdomen roughly granulate.

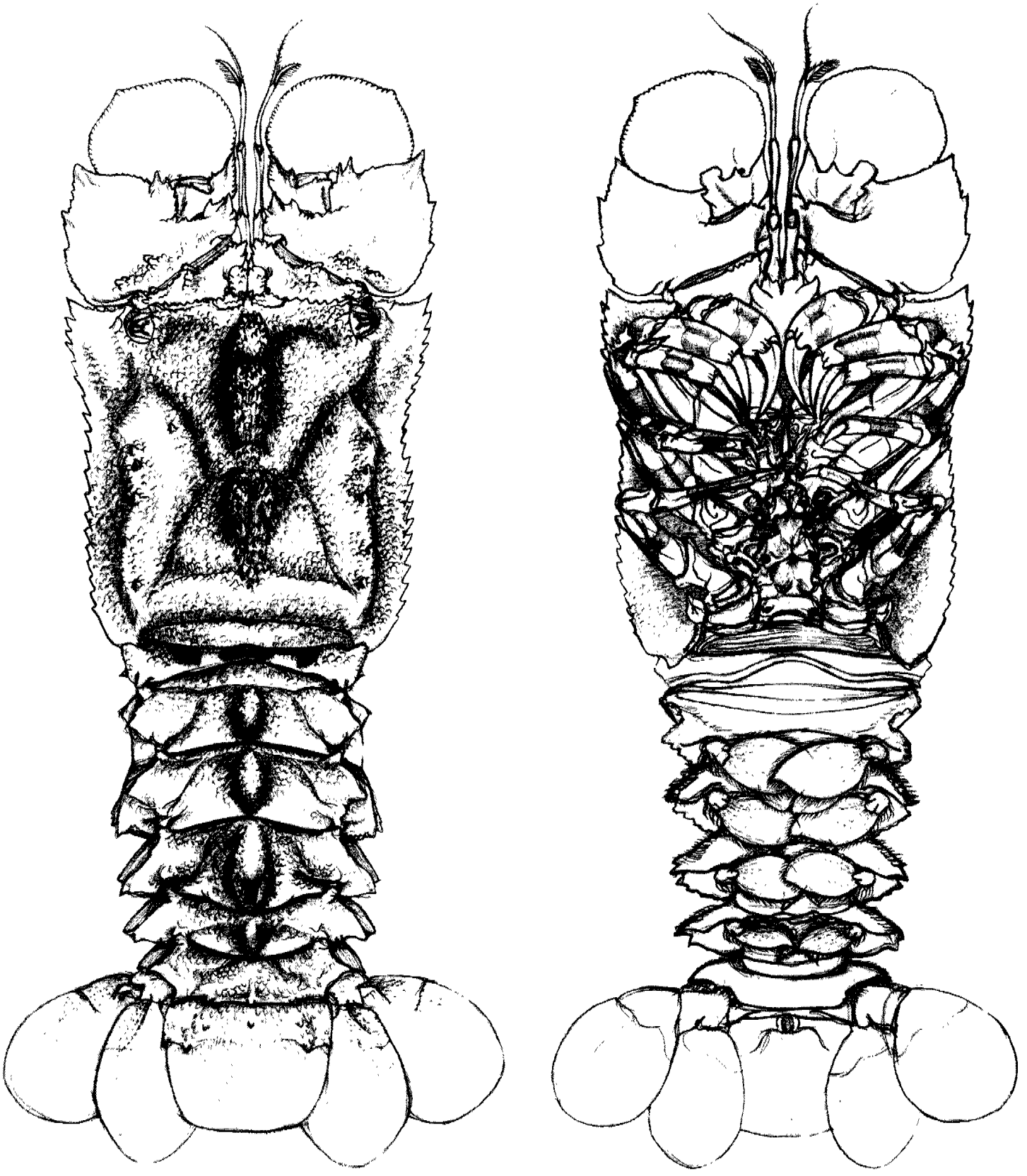


Figure 3. *Scyllarides nodifer*, ♀: CL = 80.3 mm; FSBC I 4300.

Description. Several accurate descriptions of the lobsters discussed in this paper are already available in the literature. Stimpson (1866, 1871) gives a resume of the more important characters of *Scyllarides nodifer.* Verrill (1922) added much to the description when he established the synonym *S. americanus.* Williams (1965) provides such an excellently detailed description of the species in his account of the decapod crustaceans of North Carolina that to attempt to reproduce such work here would only result in needless duplication. The reader is therefore referred to Williams' report for basic descriptive information. Juvenile variations are discussed on page 48.

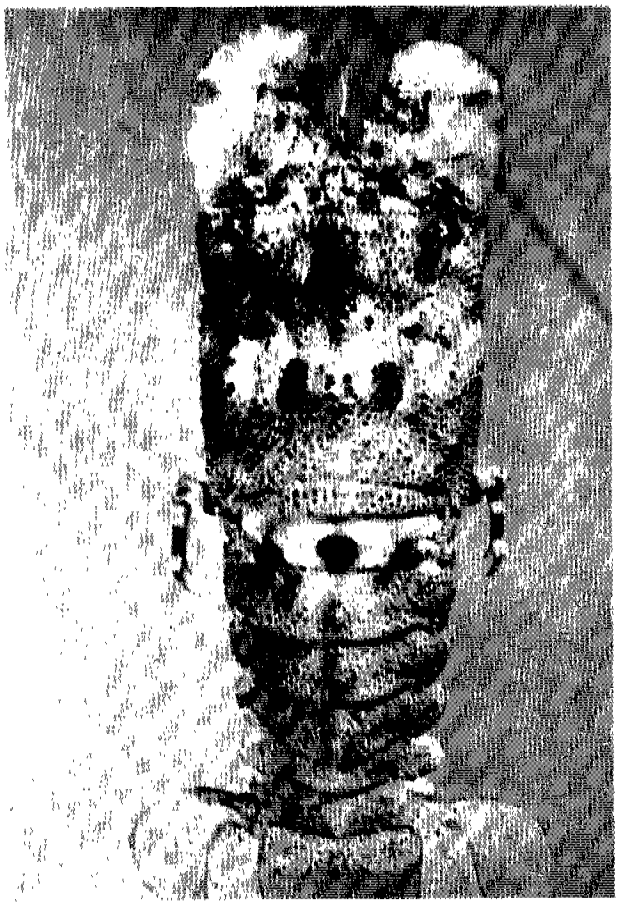
Color. Body color highly variable; dorsally changing from bright orange with patches of white in newly moulted adults to dull yellowish-brown sometime after ecdysis; young specimens from Florida Keys brick red, with broad cream band crossing posterior gastric and anterior cardiac regions and extending to lateral margins; another cream band extending along median portion of abdomen (Plate 1, Figure C); in all other specimens, these bands expressed as slightly lighter areas, nearly blending with general body color; one specimen kept through several moults at Key West laboratory pale violet-brown (Plate 1, Figure A, B). A large dark-red oval spot present on each side of cardiac region in all specimens examined; three red spots on first abdominal segment, largest located on midline and others situated slightly posterior to first, approximately midway between midline and lateral margins; antennules red, with purple flagellae; color of antennae varying to correspond with carapace and abdomen, usually with a conspicuous red spot at inner margin of distal segment, occasionally with another at base of penultimate segment; margins of antennae and anterior lateral tubercles often purple, as are larger tubercles at orbits, gastric, cardiac, and branchial regions, and median carinae of abdomen; underside pale to bright yellow with darker yellow to brown spots; legs yellow with wide red bands on propodus, carpus, and merus; pleopods white to yellow with minute brown spots.

Postlarva (Figure 4; Plate 2, Figure C). Carapace slightly broader than long, broadest portion near anterior part of cardiac region; gastric tubercle prominent, tapering as a carina to shallow cervical groove; cardiac region elevated, flattened, wider anteriorly and tapering as a carina to posterior edge of carapace; branchial region not defined; rostrum a rounded tubercle at midpoint of front; eyes round, on short stalks, may be seen through the transparent exoskeleton on ventral side; orbits about 60% distance from median line to lateral margin; a pair of low, blunt spines at each inner-orbital angle; a single spine-like tubercle at each outer-orbital angle; anterolateral spines sharp, well developed, directed forward; lateral margin of two convex arcs, anterior arc curving out from anterolateral spine, then inward to cervical groove, posterior arcs curving from cervical groove to posterior edge of carapace; intersection of the two arcs forming a prominent notch opposite gastric tubercle; six spines visible through transparent exoskeleton expressed only as slight convex rolls on anterior arc; 12 such spines and rolls occurring on posterior arc; posterior margin of carapace straight with a barely noticeable backward extension where it intersects carina from cardiac region; surface of carapace with scattered short, fine hairlike setae; granulation apparent on the newly forming exoskeleton visible through transparent outer cover.

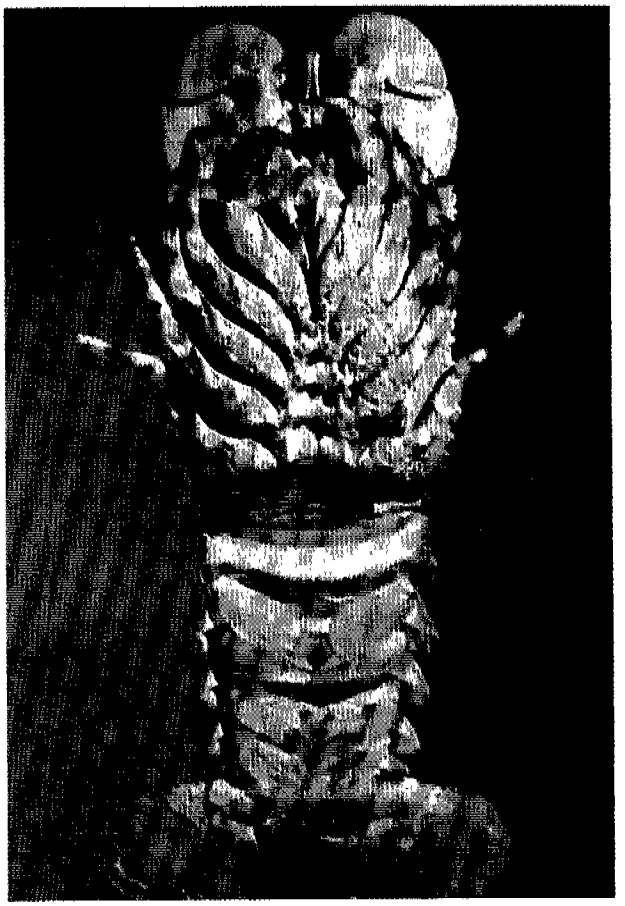
Antennae large, flat as in adult *Scyllarides,* with four movable segments, all with sparse, short, hairlike setae. Distal segment wide, tapering to sharp point anteriorly, with numerous acute spines discernible through transparent exoskeleton, expressed on margin of segment as minute spines tipped with extremely fine single setae; a low, thin ridge extending obliquely from anterior point to base of segment. Penultimate segment broader than long, projecting forward at both anterior corners, inner lateral margin folded upward to form a ridge; a single acute tubercle extending forward between anterior projections on underside of segment. Second segment broadest, with a large spine at anterolateral margin and three to five subskeletal spines expressed as blunt angles along lateral margin; an oblique dorsal ridge extending from anterolateral spine to base of segment;

Plate I.

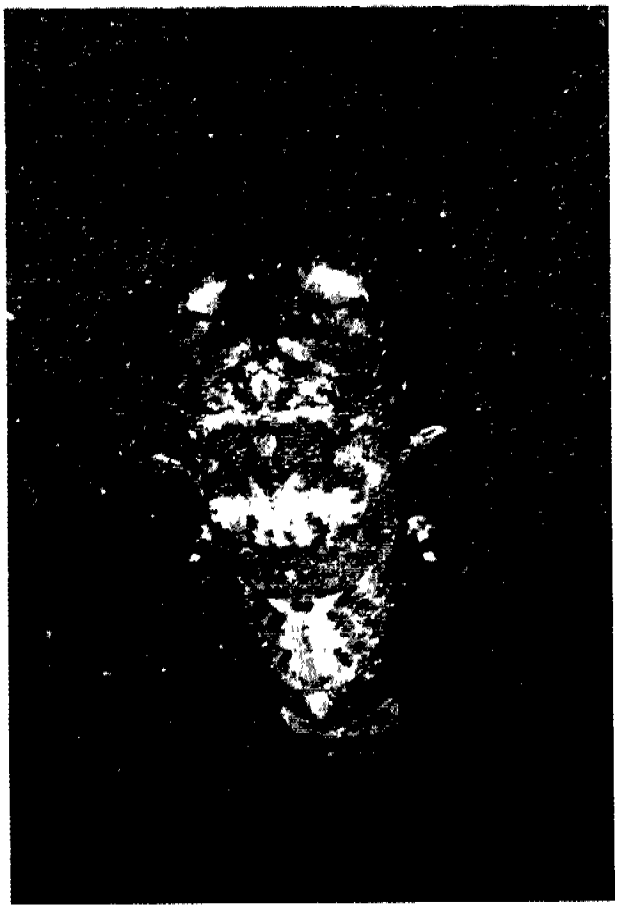
Scyllarides nodifer: (A) typical color, dorsal; (B) same, ventral; (C) color form from Florida Keys (photo courtesy of Robert Lipe).



A



B



C

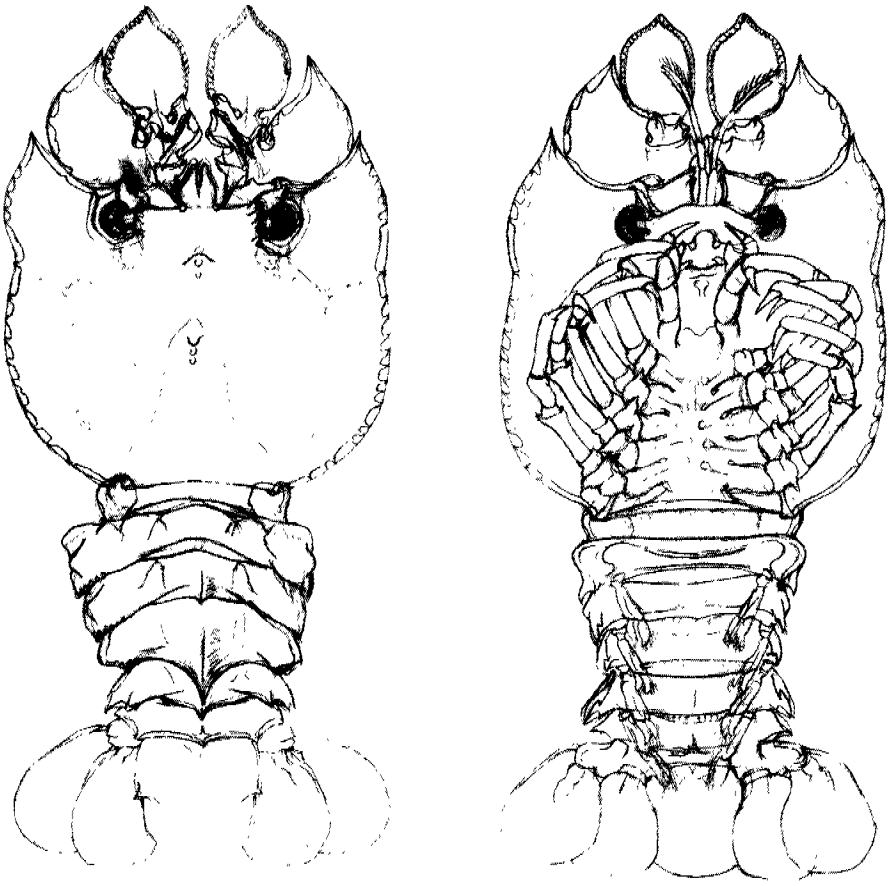


Figure 4. *Scyllarides nodifer*, postlarva; CL = 10.7 mm; FSBC I 5872.

inner margin of segment slanting obliquely to two blunt spines about half the distance to base, then extending posteriorly a short distance to a right angle, thence to an upward fold as on penultimate segment. Proximal segment with inner and outer anterior corners sharply cuneiform above, acute below, a prominent blunt spine midway between upper corners; a thin, raised ridge along lower inner margin.

Antennules shorter than antennae, extending only to midpoint of distal antennal segment; inner and outer flagellae of equal length, well developed, with a few long setae; antennular peduncles with long slender tubercle on upper distal extremity.

Notch at anterior extremity of sternum deep, U-shaped; posterior corners of last sternal segment slightly prolonged, subacute; posterior edge of sternum otherwise straight.

Legs not projecting beyond carapace; fifth pair much smaller than others; merus, carpus, and propodus of all pairs with a poorly defined dorsal carina, ending distally on merus and carpus with a spine and on propodus with a blunt tooth; about six large setae at underside of distal end of propodi of fifth legs; dactyli slender, curved, with four or five large setae near middle of underside of third, fourth, and fifth pairs; tips of dactyli corneous; single large spines directed posteriorly on coxi of fifth pair.

Mandible (Figure 5a) poorly developed, soft; outer edge slightly sinuose, a tooth at upper corner; prominent palp at upper margin unsegmented; developing mandible, seen through exoskeleton, with about eight extremely small teeth on outer edge.

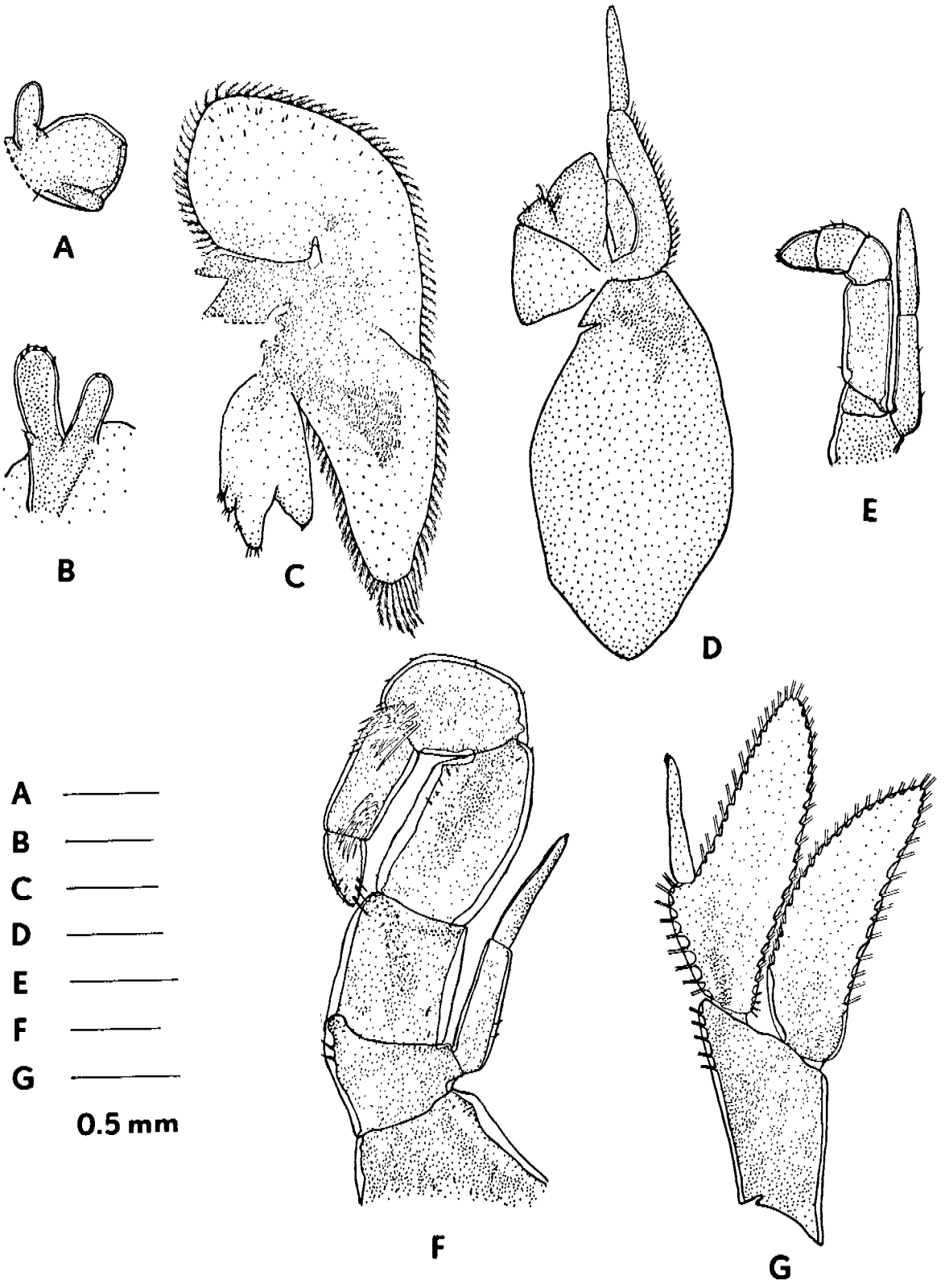


Figure 5. *Scyllarides nodifer* postlarva: (A) mandible; (B) first maxilla; (C) second maxilla; (D) first maxilliped; (E) second maxilliped; (F) third maxilliped; (G) pleopod 1.

First maxilla (Figure 5b) with extremely small endopod tipped with one fine seta; endite 1 swollen distally with five blunt teeth on distal margin; endite 2 slightly smaller than endite 1, with two blunt teeth on distal margin.

Second maxilla (Figure 5c) with broad scaphognathite; numerous single setae near upper margin of epipodite; both fringed with plumose setae; endite 1 consists of two rudimentary buds, each tipped with three or four short, hairlike setae; endite 2 much larger than endite 1, bilobed, each lobe subacute, the outer with five fine setae distally, two more on outer lateral margin; inner lobe more rounded with a single tooth distally.

First maxilliped (Figure 5d) with endopod of two segments, proximal segment broader, fringed on outer lateral margin with about 24 plumose setae; exopod small, ovo-elongate, without setae; endite 2 with four simple and two plumose setae on lower half; epipod large, broad, oval.

Second maxilliped (Figure 5e) with endopod of five segments, longest being the merus; a low, blunt spine and two setae at distal end of dactyl; single spine-like seta at outer distal angle of propodus, two on outer lateral margin of propodus, one at outer distolateral angle of carpus and one near inner proximal angle of merus. Exopod of two segments, the proximal with two simple setae on outer lateral margin.

Third maxilliped (Figure 5f) with endopod five-segmented; ischium with three short simple setae near outer lateral margin; merus with five such setae near inner distolateral angle and three near outer, a low tubercle at distal edge; carpus with four such setae on outer margin, a cluster of about 16 long spinose setae distally; propodus with about 12 slightly shorter spinose setae on distal half; dactylus with three spinose setae on distal half and six short, simple setae on outer distolateral margin. Exopod well developed, of two distinct segments; two simple setae on outer lateral margin of proximal segment; distal segment straight; basis with two spine-like setae at inner lateral margin.

Abdomen at widest point about 60% greatest width of carapace; abdominal tergites with median carina on second through sixth, quite prominent on second through fifth, barely discernible on sixth; carina terminating posteriorly in spine-like tubercle on tergites 2, 3, and 6, and in large acute spine on tergites 4 and 5, spine of fourth slightly greater than fifth; inconspicuous sulci extending from distolateral margins to middle of median carina on tergites 2 through 5. Pleura of tergites 2 through 5 faintly papillose, with a low, blunt tubercle centrally located in upper portion; pleuron 2 subacute distally, with a small spine at posterior angle and a slightly larger but more blunt spine at anterior angle; pleuron 3 with a downward-directed tubercle at lower margin and a small, obtuse, distally-directed spine at posterior angle; pleuron 4 with two equal subacute spines, the anterior one directed downward and the posterior one directed distally; pleuron 5 with a small downward-directed spine at anterior angle, a conspicuously large, acute, distally-directed spine at posterior angle, and an acute tubercle at posterior upper margin; a well developed spine-like tubercle at each posterior corner of tergite 6, a smaller tubercle on each side midway to median tubercle. Anterior, calcified portion of telson with single small tubercle at each posterior corner, slightly concave between; membranous portion flattened, straight distally, with rounded corners. Uropods with two blunt tubercles proximally, broadly rounded distally; dense fine setae around margins of telson and uropods.

Pleopods (Figure 5g) biramous, well developed; endopods and exopods of approximately equal length, fringed with long, plumose setae; endopods with a rod-like appendix interna not extending to distal end of endopod; each appendix interna with dense cluster of cincinnuli at inner margin of tip; basipodites of pleopods nearly as long as exopods and endopods, truncate distally, with six short plumose setae on inner distolateral margin of first, five on second, and four on third and fourth.

Type Locality: Florida Keys.

Range: Gulf of Mexico; Yucatan and Cuba to North Carolina; Bermuda; 2 to 91 meters.

Material examined – MEXICO: 1 ♂, 35.1 mm; off Cape Catoche, Yucatan; *Albatross* Sta. 2366; USNM 9596. - TEXAS: 1 ♂, 82.6 mm; Rockport; J. L. Baughman; USNM 92656. – LOUISIANA: 1 ♂, 89.4 mm; off Pass a' Loutre, 55 m; Martin Town; USNM 104401. – 1 ♂, 84.0 mm; off Pass a' Loutre; Ray Fournier; USNM 104561. – WEST FLORIDA: 1 ♂, 87.2 mm; Pensacola; Silas Stearns; USNM 4511. 1 ♀, 23.0 mm; Pensacola; S. Stearns; USNM 4606. – 1 ovig. ♀, 100.2 mm; Pensacola; "in fish stomach"; Silas Stearns; USNM 14476. – 1 ♂, 67.0 mm; 29°16'N X 85°08'W, 29-26 m; *Silver Bay.* Sta. 42; USNM 104565. – 1 ♀; off Alligator Point, Franklin Co; J. Rudloe; USNM 128028. – 1 ♀; southwest of Bell Pass, 44 (?) m; vessel *Melba Sue*; USNM 128026. - 1 ♀, 34.0 mm; 29°10'N X 85°01'W, 29 m; *Oregon* Sta. 730; USNM 94441. – 1 ♀, 67.9 mm; 29°08'N X 85°00'W, 31.0 m; *Pelican* Sta. 156-2; USNM 104564. – 2 ♀, 54.9-58.0 mm; 29°06'N X 84°52'W, 35 m; *Silver Bay* Sta. 91; USNM 101643. – 1 ♀, 52.9 mm; 29°02'N X 84°43'W, 37-35 m; *Silver Bay* Sta. 88; USNM 101318. – 1 ovig. ♀, 88.6 mm; 27°50'N X 83°15'W, 24 m; FSBC I 1474. – 1 ♂, 70.5 mm; 27°15'N X 83°08'W, 27 m; FSBC I 458. – 1 ♀, 35.0 mm; 27°07'N X 83°50'W, 62 m; *Oregon* Sta. 959; USNM 97440. – 1 juv., 10.7 mm; 26°34'N X 83°24'W, 51 m; FSBC I 488. – 1 ♂, 31.8 mm; 26°31'N X 83°17'W, 44 m; FSBC I 480. – 1 ♂; 26°25'N X 83°52'W, 91 m; *Hernan Cortez* Sta. 159; USNM 128027. – 1 juv., 10.8 mm; 26°24'N X 83°27'W, 71 m; FSBC I 481. – 5 ♂, 28.9, 54.1, 61.0, 66.8, and 75.6 mm, 3 ♀, 54.4, 55.6, and 71.4 mm; 26°12'N X 83°15'W, 55 m; FSBC I 554. – 1 ♂, 68.1 mm; 26°07'N off west Florida, 49 m; FSBC I 3285. – 1 ♀, 33.8 mm; 25°53'N X 83°17'W, 55 m; FSBC I 592. – 1 ♀, 41.0 mm; 25°39'N X 83°23'W, 60 m; FSBC I 591. – 1 ♂, 52.7 mm; 25°39'N X 83°39'W, 64 m; FSBC I 613. 1 ♂, 54.5 mm; 25°26'N X 83°10'W, 54 m; FSBC I 568. – 1 ♀, 58.8 mm; 25°10'N X 83°05'W, 55 m; FSBC I 573. – 89 specimens from regular Hourglass collections (Table 3); 67 specimens from Hourglass trapping stations (Table 10). – 1; off Dry Tortugas, 73 m; W. L. Schmitt; USNM 104566. - EAST FLORIDA: 1 juv. Key Vaca, 2 m; Robert Lipe; FSBC I 6922. – 4; upper Florida Keys; Provenzano. – 3 postlarvae, 9.3-9.8 mm; under night-light at Bear Cut, Biscayne Bay; Robertson. – 1; Biscayne Bay off Homestead, on a shallow bank; R. Cochran; USNM 104563. - 1 ♂, 74.4 mm; off Palm Beach, 15 m; FSBC I 3220. – 1 ♂; Fernandina Sea Buoy; *Pelican* collection; USNM 104562. – 1 ♀; between Savannah, Georgia and Cape Canaveral, Florida; Silas B. Latham; USNM 15617. – SOUTH CAROLINA: 1; about 20 miles off coast near McClellanville, 37 m; R. T. Morrison; USNM 105724. - BERMUDA: 1 ♂; T. H. Bean; USNM 21607 (Paratype of *Scyllarides americanus* Verrill).

Scyllarides aequinoctialis (Lund)

Plate 2, Figures A, B

Scyllarus aequinoctialis Lund, 1793, p. 21; Fabricius, 1798, p. 339; Bosc, 1802, p. 19; H. Milne-Edwards 1837, p. 285, pl. 24, fig. 6; Gibbes, 1850, p. 193; Rankin, 1869, p. 535; Smith, 1869, p. 18; von Martens, 1872, p. 123; Ortmann, 1897, p. 268; Rathburn, 1897, p. 43.

Scyllarus equinoxialis Dana, 1852, p. 516.

Scyllarides aequinoctialis Gill, 1898, p. 99; Rathbun, 1901, p. 97, 1906, p. 113; Bouvier, 1913, p. 1646, 1917, p. 101; Verrill, 1922, p. 19, fig. 3; Boone, 1925, p. 88, 1930, p. 80, pl. 22; Schmitt, 1935, p. 174, fig. 38; Holthuis & Zaneveld, 1958, p. 14, pl. 1; Hildebrand, 1954, p. 271; Holthuis, 1959, p. 129; Butler & Pease, 1965, p. 20; Robertson, 1968a, p. 119, 1968b, p. 334, 1968c, p. 94.

Pseudibacus gerstaeckeri Pfeffer, 1881, p. 51; Miers, 1882, p. 542; Bouvier, 1913, p. 1646, 1917, p. 101.

Diagnosis. Carapace broadest near cardiac region; gastric, cardiac, and branchial regions low, not strongly defined; pregastric and gastric teeth not obvious in profile; second through fourth abdom-

inal segments low, rounded, without distinct carina; usually five large spots on upper surface of first abdominal segment; carapace and abdomen smoothly granulate.

Description. Carapace oblong, distinctly longer than broad, widest near posterior edge; unevenly granulate; granules low, smooth, each surrounded by small, stiff hairs; anterolateral corners forming a slightly obtuse angle; cervical groove and notch weakly defined; lateral margins slightly convex, with numerous low, anteriorly-directed denticles; gastric area swollen, broad, descending markedly at front; cardiac region broad, weakly elevated, defined by shallow branchial grooves; branchial areas oval, sloping gently to lateral margins; posterior angles thickened, swollen, obtusely rounded; posterior transverse groove deep, conspicuous; posterior margin convex, with numerous short hairs at edge; orbits large, with prominent, raised borders crenulated by coarse granules, notched at front; two large, rounded granules at outer orbital angle; eyestalks short, stout, tapered, conspicuously striped.

Antennae large, flat, of four movable segments; distal segment broad, rounded, minutely serrate, with numerous short hairs on anteriorly directed teeth; upper side covered with tufts of very short hairs. Penultimate segment small; inner margin extending forward, folded upward, and with several sharp granular teeth; underside with prominent tooth at center of anterior edge; both anterior angles of underside extending forward as slender lobes. Second segment largest, broader than long, coarsely granulate proximally; outer margin slightly convex, with large and small anteriorly directed teeth; distal margin nearly straight, serrate as outer margin; inner margin folded upward, extending forward as on penultimate segment, with two sharp, granular teeth; anterolateral spine prominent, blunt; low, indistinct ridge extending obliquely from this spine to near center of proximal edge. Proximal segment thickened, coarsely granulate, subtriangular above, trapezoidal beneath, widest distally; inner distal angle of upper side with three prominent, divergent, obtuse teeth enclosing rostrum laterally, nearly meeting in front; two obtuse teeth at center of distal margin, two more at outer distal angle; a large granular tooth on proximal margin near outer angle; inner margin on underside a thick, granular ridge.

Antennules longer than antennae; inner and outer flagellae segmented, of approximately equal length; distal third of exopod with dense setae; endopod sparsely setose near tip; distal end of antennular peduncle with obtuse tooth above, two acute teeth below.

Prefrontal or rostral lobe coarsely granulate, slightly bilobed, swollen near distal end, concave laterally, with distinct median groove.

Sternum slender, rugose; sternal somites much thickened, with deep depressions between; each somite, except that between fifth legs in females, bearing a pair of large, obtuse conical spines partially covered, like spaces between them, with low, relatively inconspicuous granules; posterior edge distinctly concave.

Legs projecting beyond carapace; first pair stouter than others, fifth pair least stout; merus of all legs with a well-developed, hairy longitudinal carina; carpus of first and second pairs with a shallow, longitudinal dorsal incision, third through fifth pairs with a prominent dorsal carina; propodus of all pairs with longitudinal carina, prominent on pairs one, three, and four, indistinct on pairs two and five; propodus of fifth pair in females extending at underside of distal end to form finger which articulates with dactylus, creating a pincer which is covered on inner surfaces with fine sensory hairs; dactyli large, decreasing in length from first to fifth pair; small cluster of sensory setae at base of dactyl of second leg, two larger clusters at base of third and fourth legs; tips of all dactyli corneous; ischium and basis of all pairs fused; coxi of all pairs granulate, outer anterior angles acute, those of fifth pair with two large triangular teeth extending almost to distal end of ischium.

Outer (third) maxillipeds large; ischium and merus broad, stout, granular; outer margin of ischium serrate with many short, sharp spines, inner margin with two carinae, the upper with about ten low, corneous teeth, the lower indistinctly serrate; margins of merus similar to those of ischium, except inner upper carina which bears three to four sharp, corneous-tipped spines on proximal half only and many long, hairlike setae along entire length; carpus short, rounded, with an outer lateral carina densely covered with short, hooked spines; distal two-thirds of upper surface covered with dense, short setae; propodus nearly as long as merus with spinose outer lateral carina and dense hairs on upper surface as on carpus; dactylus short, swollen, inner and outer margins with many large curved spines, longest at inner distal end. Endopod long, of two setose segments; distal segment with secondary segmentation.

Abdominal terga granulate as is carapace; all with numerous short hairs behind. First segment short, narrower than second, lateral region more coarsely granulate; anterior corners acute with a broadly rounded tooth; about four lesser, rounded teeth at outer margin; posterior corners obtuse, with a broadly rounded tooth. Second segment twice as long as first, a transverse constriction near anterior margin, remainder of segment convex, slightly humped in median region; posterior edge concave at midline, otherwise sinuose; lateral margin rounded anteriorly, angled posteriorly, with 10 to 15 rounded teeth, largest on anterior half; a distinct V-like groove on epimeral region and oblique groove from posterior corner to anterior transverse constriction. Third segment like second but with pleural margin narrower, angled anteriorly and posteriorly, distinctly notched on outer margin, overlapped on anterior margin by pleuron of second segment. Fourth and fifth segments similar to preceding ones at midsection but with smaller, blade-like pleura; pleura smooth at anterior margin, granulate and finely dentate posteriorly, a small notch just posterior to rounded outer angle, V-shaped groove indistinct or absent. Sixth segment lower than second through fifth; two shallow transverse grooves across center, interrupted at midline by slightly swollen area; pleuron sharply acute, smooth anteriorly, granulate behind; posterior lateral margin concave, finely dentate; posterior edge slightly convex, with a broad, low granule at midline, another slightly more than halfway from midline to posterior corners. Telson wider than long, slightly tapered; proximal, calcified portion granulate, setose posteriorly, distinctly concave at middle of posterior edge. Distal, flexible portion heavily setose, with many fine radiating riblets; distal corners broadly rounded, posterior edge straight. Uropods broad, oval, longer than telson; granulation and setation similar to that of telson.

Abdominal sterna of males with a sharply raised, serrate, sclerotized ridge on second through fifth segments, that of second segment best developed and largest. Abdominal sterna of females low, without serration.

Pleopods biramous; those of females large, ovo-elongate, with greatly reduced appendix interna on first pair; second through fourth pairs smaller than first, but with larger appendix interna, giving the endopods a pincer-like appearance. Male pleopods narrow, bladelike, proportionally smaller than those of female, without appendices internae; endopod and exopod of approximately equal length on first pair, greatly reduced on second through fourth pairs.

Color. Body color consistent in 13 adults living or freshly dead examined by the author. Dorsally, general color dull reddish brown with patches of lighter orange brown near intersection of midline and cervical groove and on anterior portions of middle of abdominal terga. A large dark brown spot on each side of anterior portion of cardiac region, another such spot on each side of midportion of the gastric region; first abdominal segment with five prominent dark brown spots, posterior median spot about one-fourth as large as the two lateral pairs, pair nearest median spot somewhat forward of others; second segment with a small dark brown anterior spot which is continuous with median spot of first segment; similar median spots present on third, fourth, and fifth segments, but not apparent unless abdomen is folded under to expose anterior portions. Antennae yellowish orange,

with distal and lateral margins fringed with reddish to dark brown; a large brown spot at outer proximal corner of second antennal segment; antennules intense deep blue. Telson and uropods yellow-orange with small scattered brown spots. Underside yellow to yellow-orange, with light brown spots on distal antennal segments, sternum of carapace, and outer margins of uropods; legs yellow-orange, with scattered dark brown spots; similar spots clustering to form broad brown bands on propodi, carpi, and meri of third through fifth pairs of legs; pleopods yellow, without spots.

Postlarva (Figure 6; Plate 2, Figure D). Carapace smooth, flattened, broader than long, broadest portion near posterior of gastric region; gastric region slightly elevated, bearing a sharp carina with two blunt teeth; cardiac region with two short lateral carinae anteriorly and a median carina extending from front slope to back of carapace, a blunt tooth-like spine about 25% the distance from anterior end; branchial region low, poorly defined, with a low, arcuate ridge around outer margin, extending from rear of carapace to shallow cervical groove, anterior half of ridge smooth, posterior half sparsely granulate; rostrum a rounded tubercle at midpoint of front; eyes round, on short stalks, visible through underside of carapace; orbits about 40% distance from median line to lateral margin; three low teeth on sharp ridge at each inner-orbital angle; a single spine at each outer-orbital angle; anterolateral spines sharp, well developed, directed forward; lateral margin of two convex arcs, short anterior arc extending from anterolateral spine to cervical groove, longer posterior arc from cervical groove to rear of carapace; nine low spines on anterior arc, 16 to 18 such spines on posterior arc, spines much stronger on developing carapace visible through transparent exoskeleton; intersection of two arcs forming a prominent notch opposite area where cervical groove crosses median line of carapace; extreme posterolateral sections of carapace heavily granulate; posterior margin convex, with a low rounded tubercle at midline.

Antennae large, flat, with four movable segments. Distal segment wide, tapering to obtuse angle anteriorly, with numerous low lateral spines directed forward, often tipped with extremely fine short setae. Penultimate segment broader than long, projecting forward at both anterior corners; inner lateral margin folded upward to form a ridge; blunt tooth projecting forward between anterior corners on underside of segment. Second segment broadest, with large, acute anterolateral spine; two large blunt teeth on anterior half of outer lateral margin, two smaller teeth on posterior half (both distal and second developing segments visible through transparent exoskeleton possess many strong, acute teeth on lateral margins); inner margin slanting obliquely from anterolateral spine to a sharp tooth and a blunt tubercle at midpoint, then posteriorly a short distance to a right angle, thence to a bilobed upward fold; indistinct oblique dorsal ridge extending from anterolateral spine to base of segment. Proximal segment subtriangular dorsally; distal margin widest, with a strong tooth at midpoint; inner margin folding upward as on previous two segments, with acute spine at anterior corner; outer corner of segment cuneiform, a sharp spine projecting posteriorly at tip; lower inner margin a thin ridge.

Antennules nearly as long as antennae, extending to inner distolateral corner of distal segment; inner and outer flagellae of equal length, segmented; exopod with dense cluster of setae on distal half; endopod with a few setae near middle; antennular peduncle with long, slender tubercle on upper distal extremity.

Notch at anterior extremity of sternum deep, V-shaped; posterior corners of last sternal segment produced to an acute spine; posterior edge of sternum slightly convex.

Legs not projecting beyond carapace, decreasing in length from first to fifth pair; merus, carpus, and propodus of all pairs with a well developed dorsal carina; propodi subrectangular, without spines, third through fifth with tooth-like upper distal corner; all carpi with a long, sharp spine at upper distal end, a high, blunt tooth at upper proximal end; a smaller, sharper tooth at lower distal corner of third through fifth pairs; meri of all pairs with a large sharp tooth at upper distal

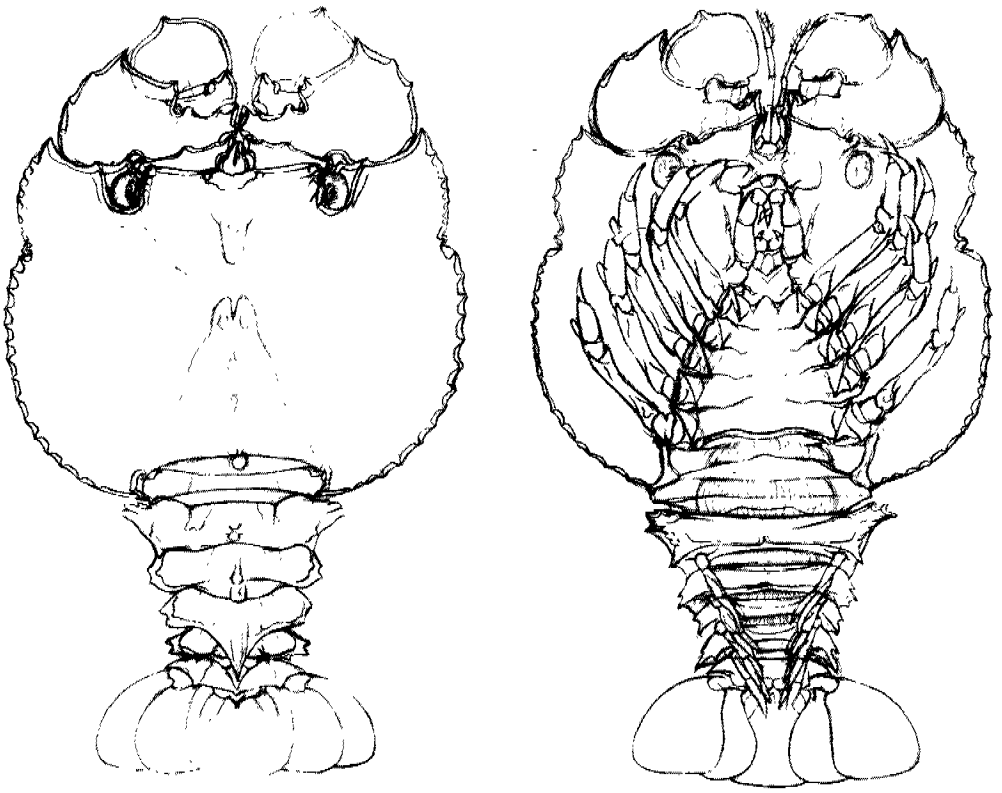


Figure 6. *Scyllarides aequinoctialis* postlarva: CL = 12.8 mm; FSBC I 886.

extremity, another at each side of lower distolateral end; dactyli slender, curved, with two to four setae near base of third, fourth, and fifth pairs; tips of dactyli corneous; coxi of fifth pair each with a large sharp spine projecting posteriorly and an elongate, hooked tubercle extending almost to distal end of ischium on outer margin.

Mandible (Figure 7a) poorly developed, soft; outer margin sinuose, a tooth near upper corner; prominent palp of two segments at upper margin.

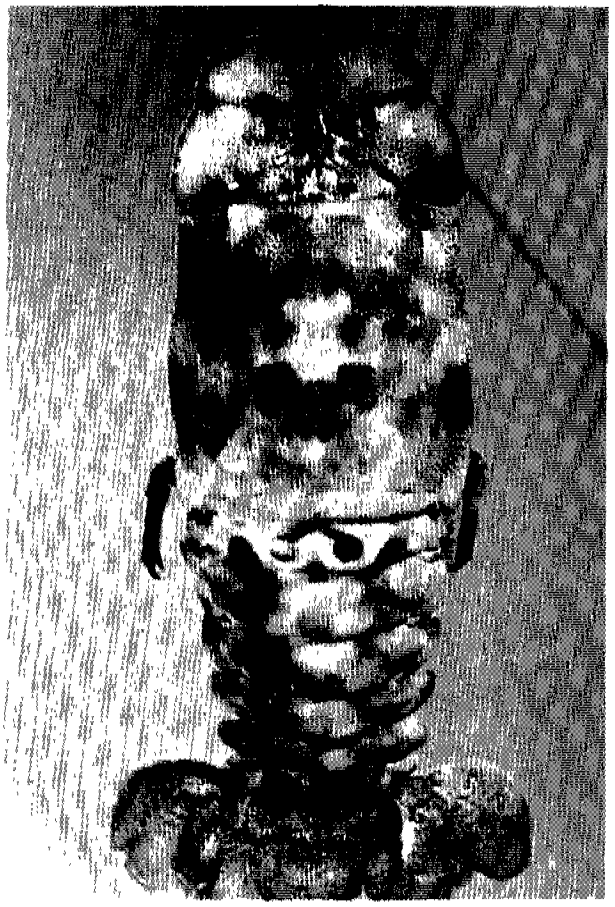
First maxilla (Figure 7b) with small endopod; endite 1 swollen distally, with five teeth on distal margin; endite 2 smaller, with four teeth at distal margin.

Second maxilla (Figure 7c) with broad scaphognathite; junction of scaphognathite and epipodite indistinct; both fringed with plumose setae; endite 1 bilobed; upper lobe with single seta at lateral margin, four setae distally; lower lobe with a single lateral seta, five distal setae; endite 2 slender, rounded, not distinctly bilobed, six setae distally, protuberance on inner margin above endite 2 may be rudimentary lobe.

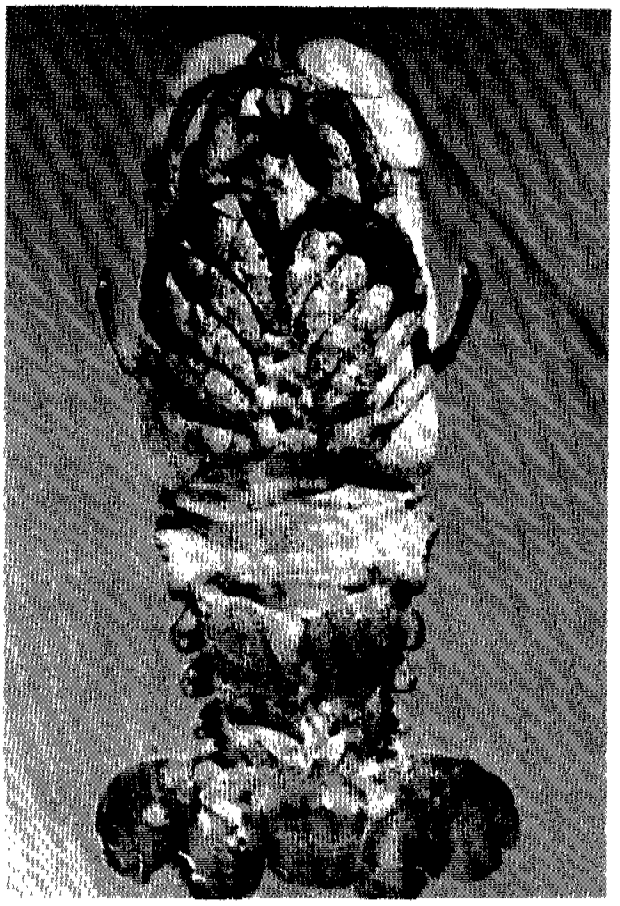
First maxilliped (Figure 7d) with endopod of two segments, proximal broader and fringed on outer lateral margin with about 20 plumose setae; a single plumose seta near inner distal angle; exopod small, ovo-elongate, without setae; endite 2 with four simple setae on lower half; epipod large, broad, oval.

Plate II.

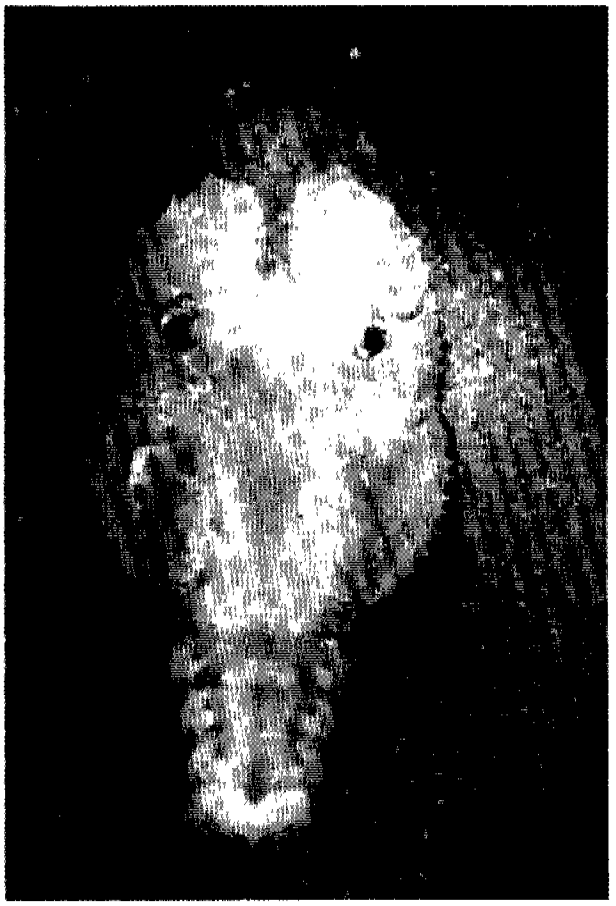
(A) *Scyllarides aequinoctialis*, dorsal; (B) same, ventral; (C) *Scyllarides nodifer* postlarva; (D) *S. aequinoctialis* postlarva.



A



B



C

D

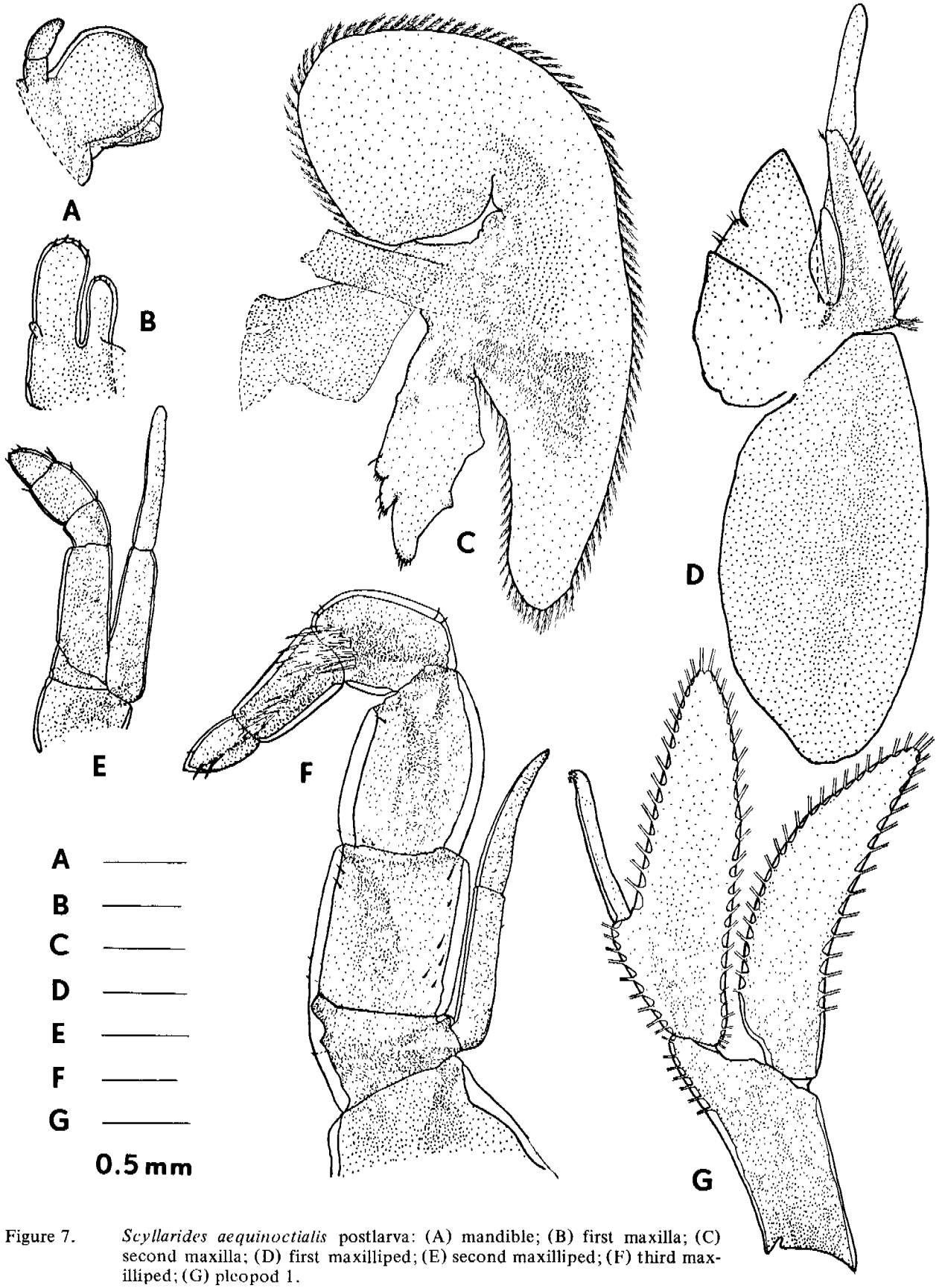


Figure 7. *Scyllarides aequinoctialis* postlarva: (A) mandible; (B) first maxilla; (C) second maxilla; (D) first maxilliped; (E) second maxilliped; (F) third maxilliped; (G) pleopod 1.

Second maxilliped (Figure 7e) with endopod of five segments, longest being the merus; dactylus with low, blunt spine at tip, four slender spine-like setae near tip; propodus with four setae at distal edge, one more on outer lateral margin; carpus with a single seta at outer distal angle. Exopod of two segments, without setation.

Third maxilliped (Figure 7f) with five-segmented endopod; ischium with six short simple setae near outer lateral margin, three near inner distolateral margin; merus with one short, simple seta near inner distolateral margin, two such setae near inner proximal angle, a low tubercle on distal edge; carpus with two pairs of short, simple setae on outer margin, a cluster of about 20 long, spinose setae distally; propodus with about 12 slightly shorter spinose setae on distal half; dactylus with two spinose setae on distal half, a short simple seta on outer margin near tip; an indistinct ridge near inner margin of propodus and dactylus. Exopod well developed, of two segments; proximal segment with a simple seta on outer lateral margin; distal segment curved outward near tip.

Abdomen at widest point about 60% greatest width of carapace; abdominal terga with strong median carina on second through fifth, weaker on sixth; carina terminating posteriorly in a single large tubercle on second tergum, in a large granulate, bifurcated tubercle on third, in large single slightly granulate spines on fourth and fifth, and in a small spine on sixth. Inconspicuous sulci extending from distolateral margins to near midpoint of median carina on terga two through five; single line of short setae across posterior margin of all terga. Pleura of segments 2 through 5 spinose, granulate, each with two prominent tubercles, largest in center of upper half, smaller above and distal to larger, a small tubercle at upper anterior and posterior corners of each pleuron. Second pleuron largest, with six rounded teeth on anterior margin; an acute spine at lower extremity; seven low, rounded teeth on upper third of posterior margin which is otherwise smooth. Third pleuron smooth on anterior margin except for a blunt tooth at lower anterior corner; lower half of posterior margin smooth, upper half with six small, rounded teeth. Fourth pleuron with smooth anterior margin, a very small tubercle at lower anterior corner; large blunt tooth on lower margin; large sharp spine at lower posterior corner; posterior margin smooth except for two small, rounded teeth near upper corner. Fifth pleuron with smooth anterior margin, a very small tubercle at lower anterior corner; large blunt tooth on lower margin; large sharp spine at lower posterior corner; single large, sharp spine near midpoint of posterior margin. Sixth tergum with single large spines directed laterally at anterior corners and posteriorly at posterior corners; single small tubercles midway between each posterior corner spine and median spine. Anterior, calcified portion of telson with prominent spine at each distal corner; large tubercle on midline just anterior to center; membranous portion flattened, distal edge straight, rounded at corners. Uropods broad, rounded; proximal, calcified portion of exopods and endopods truncate; small spine at distolateral corner and six small spines near middle of distal margin of exopod; large acute spine at distolateral corner, blunt tooth on distal margin of calcified portion of endopod; dense, fine setae around margins of telson and uropods.

Pleopods (Figure 7g) biramous, well developed; endopods and exopods of approximately equal length, fringed with long, plumose setae; endopods with a rod-like appendix interna which does not extend to distal end of endopod; each appendix interna with dense cluster of cincinnuli (Figure 8) at inner margin of tip, a plumose seta at tip on second, third, and fourth pleopods (Hourglass specimen only); basipods nearly as long as endopods and exopods, truncate distally, with six short, plumose setae on inner distolateral margin of first, seven on second, and five on third and fourth.

Type Locality: Jamaica

Range: West Indies and Caribbean Sea; Gulf of Mexico; southern Florida to Bermuda; 0-183 meters.

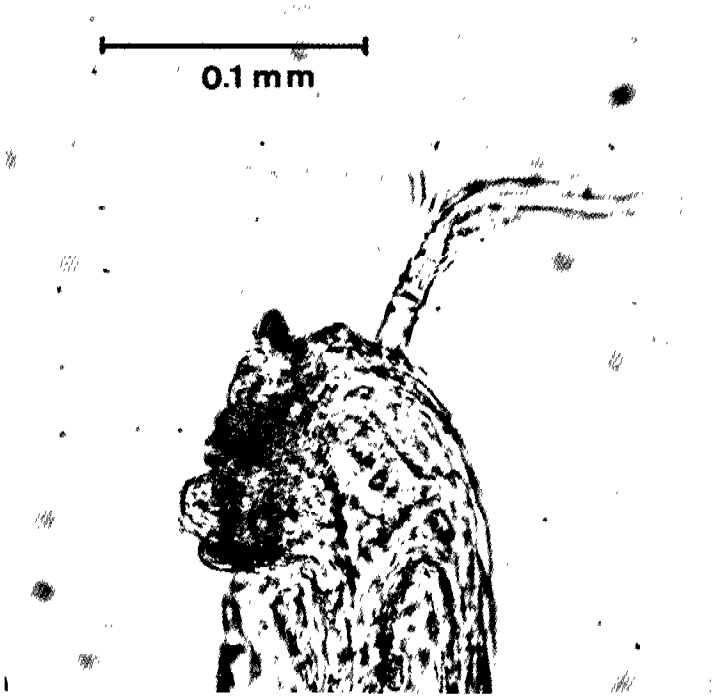


Figure 8. Plumose seta at tip of appendix internae of *Scyllarides aequinoctialis* postlarva (FSBC I 886) from Hourglass Station M.

Material examined – GRENADA: 1 ♂; Sebastian Gates; USNM 61832. MARTINIQUE: 1; Fort de France fish market; Smithsonian-Hartford Expedition Sta. 49; USNM 104181. – DOMINICA: 1; Roseau; A. H. Verrill; USNM 32508. · MONSERRAT: 1 postlarva, 14.0 mm; 16°42'N X 62°14'W; *Oregon* Sta. 5985; USNM 128030. – ANTIGUA: 1; Johnson's Point near Crab Hill, under rocks; Smithsonian-Bredin Expedition Sta. 124-58; USNM 104402. – VIRGIN ISLANDS: 1; Christiansted, St. Croix; H. A. Beatty; USNM 104569. – 2; south side of Buck Island, 3 miles from St. Thomas; in fish pot; C. R. Shoemaker; USNM 104180. – PUERTO RICO: 1 ♀, 54.6 mm; La Parquera, 11-24 m; Department of Marine Sciences, University of Puerto Rico. – JAMAICA: 1; *Albatross* collection; USNM 7508. -- 1; C. R. Orcutt collection; purchased at Kingston; USNM 104315. - GRAND CAYMAN: 10; 1 ♀, 99.6 mm; FSBC I 788; trapped by author, 3-15 m. – FLORIDA: 1; Tortugas; Dexter via W. L. Schmitt; USNM 104571. – 1 ♀, 105.3 mm; Tortugas; 22.0m; FSBC I 6921. – 1 ♂, 90.6 mm, 1 ♀, 96.4 mm; Tortugas shrimp grounds, 22.0 m; FSBC I 6923. – 1 ♀; Key West; J. Brunner; USNM 54598. – 1 ♂, 97.2 mm; Molasses Reef, 12.0 m; FSBC I 5873. – 1 ♂, 39.4 mm; off Plantation, Monroe Co., 24°59.5'N X 80°20.5'W, 57-64.0 m; *Silver Bay* Sta. 2366; USNM 128029. 1; 3 miles southwest of Cape Florida, Dade Co., 0.6 m; J. Canute; USNM 17004. -- 1 postlarva; Biscayne Bay, Miami Beach, on rocks 0.6 m below tide line; Mrs. J. W. Donovan; USNM 82988. 1; Miami; J. Mills; USNM 104568. – GULF OF MEXICO: 1 postlarva, 15.7 mm; Hourglass Sta. M, 73.0 m; FSBC I 886. BERMUDA: 1; T. H. Bean; USNM 21606. *Additional records:* NETHERLAND ANTILLES: St. Maarten, St. Eustatius, Curacao, Bonaire (all Holthuis & Zaneveld, 1958). – PANAMA: 1; off northwest coast, 15.0 m (Butler & Pease, 1965). – DOMINICA: "a good series"; 9-183 m (Verrill, 1922). – PUERTO RICO: Cabo Rojo; San Juan (both Rathbun, 1901). – CUBA: (von Martens, 1872). · FLORIDA: 1; off Marathon; 1; off Tavernier (both Robertson, 1968a). – 1; Biscayne Bay (Boone, 1930). – 1 postlarva; Key Largo (Robertson, 1968a). – TEXAS: 1 ovig. ♀, 90 mm; 20 miles north of Sebree Bank

(Hildebrand, 1954). – SOUTH CAROLINA: In the collection of the U.S. National Museum, there is a Kodachrome of 1 specimen taken about 25 miles off the mouth of the Santee River, collected by Mr. Jay Shuler, Greenville, South Carolina.– BERMUDA: "frequently caught in lobster traps in deep water along the outer reefs" (Verrill, 1922).

Scyllarus americanus (Smith)

Figure 9

Arctus americanus Smith, 1869, p. 119, 1872, p. 229; Ortmann, 1897, p. 270 (not *A. americanus* A. Milne-Edwards, 1880, p. 64).

Scyllarus gundlachi von Martens, 1872, p. 123, pl. 5, fig. 13 (not *Scyllarus gundlachi* Paul'son, 1875, p. 102; not *Scyllarus gundlachi* A. Milne-Edwards, 1880, p. 64).

Scyllarus americanus Rathbun, 1901, p. 97 (in part); Bouvier, 1915a, p. 290, 1917, p. 114, 1925, p. 447 (in part); Boone, 1930, p. 84 (? in part); Schmitt, 1935, p. 174 (in part); Menzel, 1956, p. 42; Holthuis, 1959, p. 127 (in part), 1960, p. 152; Tabb & Manning, 1961, p. 598; Harada, 1962, p. 109; Williams, 1965, p. 96, fig. 75; Sims, 1966, p. 288; Baisre, 1966, p. 6; Robertson, 1968a, p. 20; (not *Scyllarus americanus* Springer & Bullis, 1956, p. 14); (not *Scyllarus americanus* Bullis & Thompson, 1965, p. 9); (not *Scyllarus americanus* "v. Martens" Bouvier, 1917, p. 106).

Diagnosis. Pregastric tooth prominent, almost always bilobed, incised; gastric and cardiac teeth blunt, elevated, incised; almost always a single, distinct groove between posterior marginal groove and posterior margin of carapace; low midventral tubercle on fifth sternal plate only; first to fourth abdominal segments with a deep, narrow median notch in posterior margin; posterior margin of fifth segment without notch or median spine; fourth abdominal segment elevated, ridge-like at midline; pleura of fourth segment rounded laterally.

Description. Williams (1968:96) and Robertson (1968b:322-325) have recently presented excellent descriptions of the adults and postlarvae of this species. Repetition here is unnecessary.

Type Locality: Egmont Key, Florida

Range: Off Cape Fear, North Carolina to Venezuela; low tide to 46 meters.

Material examined – NORTH CAROLINA: 1; off Cape Fear, 27.4 m; *Albatross* Sta. 2622; USNM 11251. – 1; 34°12.5'N X 77°10'W, 23.8 m; *Pelican* Sta. 192-13; USNM 104580. – 1; 34°08.5'N X 77°31'W, 20.1 m; *Pelican* Sta. 193-2; USNM 104579. – SOUTH CAROLINA: 2; 32°52'N X 79°04'W, 20.1 m; *Pelican* Sta. 182-22; USNM 104577. – 1; 32°51.5'N X 78°59'W, 25.6 m; *Pelican* Sta. 182-23; USNM 104578. – 1; 32°34'N X 79°05'W, 34.7 m; *Pelican* Sta. 194-10; USNM 104581. – 1; Blackfish Bank off Charleston, 21.9 m; R. E. Earll; USNM 9098. – GEORGIA: 1; 31°59.5'N X 80°34'W, 14.6 m; *Pelican* Sta. 181-3; USNM 104576. – 1; 31°53'N X 80°34.5'W, 14.6 m; *Pelican* Sta. 180-5; USNM 104575. 1; 31°40'N X 80°34'W, 18.3 m; *Pelican* Sta. 196-3; USNM 104582. – 2; 31°38.5'N X 80°43.5'W, 16.4 m; *Pelican* Sta. 196-4; USNM 104583. – 1; 31°24'N X 80°44'W, 20.1 m; *Pelican* Sta. 197-3; USNM 104584. – 4; 70 miles off Sea Island; W. W. Anderson; USNM 104586. – 1; 31°13'N X 80°44'W, 20.1 m; *Pelican* Sta. 178-8; USNM 104574. – 1; 30°52.5'N X 80°51.5'W, 21.9 m; *Pelican* Sta. 177-8; USNM 104573. – 1; 30°48'N X 80°55.5' W, 21.9 m; *Pelican* Sta. 198-7; USNM 104585. – FLORIDA: 1; 30°45 N X 80°34'W, 34.7 m; *Pelican* Sta. 177-4; USNM 104484. – 1; 30°39.5'N X 81°13.5'W, 16.4 m; *Pelican* Sta. 200-3; USNM 104488. – 1; 30°27'N X 80°54'W, 25.6 m; *Pelican* Sta. 176-6; USNM 104490. – 1; 30°23.5'N X 80°41'W, 32.9 m; *Pelican* Sta. 200-9; USNM 104485. – 2; 29°53.5'N X 80°38'W, 34.7 m; *Pelican* Sta. 201-3; USNM 104487. – 1; 29°45'N X 80°48.5'W, 21.9 m; *Pelican* Sta. 202-1;

Figure 9. *Scyllarus americanus* ♀; CL = 23.1 mm; FSBC I 5941.

USNM 104491. – 1; 29°18.5'N X 80° 29.5'W, 31.1 m; *Pelican* Sta. 172-6; USNM 104489. – 1 ovig. ♀; 29°07'N X 80°35'W, 23.8-24.7 m; *Silver Bay* Sta. 4408; USNM 127990. – 2; 28°45'N X 80°27'W, 18.3 m; *Pelican* Sta. 171-2; USNM 104486. – 1 ovig. ♀, 22.2 mm; northeast of Hillsborough Inlet, Broward Co.; FSBC I 3280. – 2; Biscayne Bay, Dade Co.; *Pelican* collection; USNM 104494. – 1 ovig. ♀, 17.7 mm; 2 miles SSW Alligator Light, Monroe Co., 36.6-45.7 m; Starck and Manning; USNM 127988. – 1 ♀, 19.4 mm; Key Vaca, Monroe Co., among rocks between tides; H. Hemphill; USNM 14069. – GULF OF MEXICO: 38 specimens, 3.0-18.7 mm; 6.0-18.0 m (Hourglass collections, Table 4). – 1; Campeche snapper banks, N. E. coast of Mexico; Jos. Lee; USNM 44321. – 1 ovig. ♀; off Alligator Point, Franklin Co., Florida, 11.6 m; J. Rudloe; USNM 127989. – 1 ♂, 9.7 mm; 3 ♀, 9.4-12.8 mm; 2.5 miles offshore Keaton Beach, Taylor Co.; 3 m; C. R. Futch; FSBC I 4403. – 1 ♀, 14.2 mm; 29°21'N X 83°32'W, 12.2 m; *Fish Hawk* Sta. 7160; USNM 66331. – 1 juv., 5.5 mm; 29°15'N X 83°27'30"W; 10 m; *Fish Hawk* Sta. 7166; USNM 104471. – 1 ♂, 11.3 mm; 1 juv., 5.5 mm; *Fish Hawk* Sta. 7185; USNM 104476. – 1 ♂, 10.4 mm; 28°50'N X 83°00'W; Lt. J. F. Moser; USNM 104498. – 1 ♀, 15.2 mm; 28°47'45"N X 83°28'00"W, 21.0 m; *Fish Hawk* Sta. 7186; USNM 104475. – 2 ♂, 7.0-7.3 mm; 28°34'30"N X 83°15'45"W, 13.7 m; *Fish Hawk* Sta. 7220; USNM 104481. – 1 ♀, 8.9 mm; 28°01'30"N X 83°03'00"W, 15.5 m; *Fish Hawk* sta. 7235; USNM 104479. – 1 ♀, 9.4 mm; 28°01'30"N X 83°12'30"W, 23.8 m; *Fish Hawk* Sta. 7233; USNM 104480. – 1 ♂, 17.4 mm; 1 ovig. ♀, 23.8 mm; off Homosassa, Citrus Co., 3.0 m; FSBC I 6509. – 1 ♂, 17.6 mm; 4 ♀, 16.5-14.3 mm; Little St. Martins Reef; FSBC I 3284. – 5 ♀ (3 ovig.), 25.3-14.1 mm; 28°31'N X 82°54'W, 3.6 m; FSBC I 5941. – 61 ♂, 24.6-9.7 mm; 53 ♀ (2 ovig.), 22.6-9.9 mm; 28°28'N X 82°53'W, 3.6 m; FSBC I

5942. – 2 ♀, 16.9-13.2 mm; 7 miles NNW of New Port Richey, Pasco Co., 2.5 m; FSBC I 387. – 1 ♂, 13.9 mm; 3 ♀, 18.7-16.5 mm; 8 miles off New Port Richey, 3.6 m; FSBC I 2798. – 2 ♂, 15.3-12.7 mm, 4 ♀, 16.8-13.7 mm; offshore of New Port Richey, 2.4-3.6 m; FSBC I 416. – 5 ♂, 19.0-15.3 mm, 4 ♀ (1 ovig.) 18.4-17.9 mm; offshore of New Port Richey, 2.0 m; FSBC I 2077. – 10 ♂, 16.2-9.9 mm, 27 ♀ (1 ovig.), 17.1-8.0; New Port Richey bait shrimp area, 2.4-3.6 m; FSBC I 3289. – 1 ♂, 12.9 mm, 2 ♀, 13.5-13.6 mm; off Anclote Key; FSBC I 3279. – 1 ♀, 14.5 mm; 27°42.8' - 27°41.7'N X 83°14.8'W, 29.2 m; USNM 102040. – 4 ♂, 17.1-14.6 mm, 2 ♀, 18.2-17.5 mm; bay side of Egmont Key, 1.3 m; FSBC I 504. – 1 ♀, 7.9 mm; off Egmont Key whistle buoy, surface (bottom depth 12.1 m); FSBC I 6600. – 1 ♂, 11.4 mm; west of Egmont Key, 23.0-24.0 m; FSBC I 32. – 1 ♀, 10.4 mm; 27°30'N X 82°46'W 5.3 m; *Silver Bay* Sta. 59; USNM 101329. – 1 ♂, 16.3 mm, 1 ovig. ♀, 19.4 mm; Gulf and bay near north end of Longboat Key, Sarasota Bay; J. B. Knight; USNM 104496. – 1 ♂, 13.1 mm, 2 ovig. ♀, 18.0-17.2 mm; 27°11'N X 82°33'W, 5.3 m; *Silver Bay* Sta. 60; USNM 101330. – 2 ♀ (1 ovig.), 18.6-14.5 mm; 26°40'N X 82°20'W, 11.0 m; *Silver Bay* Sta. 63; USNM 104493. – 1 ♂, 14.8 mm; 26°19'N X 82°11'W, 11.0 m; FSBC I 1037. – 1 ovig. ♀, 18.7 mm; 26°17'N X 82°22'W, 14.6 m; FSBC I 5936. – 4 ♀ (1 ovig.), 22.7-9.2 mm; 26°17'N X 82°02'W, 11.0 m; *Silver Bay* Sta. 68; USNM 101331. – 2 postlarvae, 2.8-3.0 mm; 26°07'N X 82°10'W, 18.3 m; FSBC I 6901. – 2 ♀, 13.6-11.8 mm; Marco, 3.7 m; H. Hemphill; USNM 6993. – 1 ♀, 17.5 mm; 25°58'N X 81°54'W, 9.1 m; FSBC I 560. – 1 ♀, 19.3 mm; 25°26'N X 81°40'W, 8.2 m; *Silver Bay* Sta. 71; USNM 101332. – 1 ♂, 12.4 mm; 25°10'10"N X 81°28'30"W, 8.5 m; *Fish Hawk* Sta. 7354; USNM 104482. – 1 ♀, 13.8 mm; 25°09'52"N X 81°21'53"W, 6.7 m; *Fish Hawk* Sta. 7352; USNM 104477. – 1 ♂, 15.3 mm; 25°07'10"N X 81°29'00"W, 9.1 m; *Fish Hawk* Sta. 7361; USNM 104472. – 1 ♂, 9.9 mm; 25°07'N X 81°16'W, 4.9 m; FSBC I 1238. – 1 ♀, 15.2 mm; west end of Content Key, 2.5 miles off Cape Sable, 8.5 m; *Fish Hawk* Sta. 7391; USNM 104474. – 1 ♀, 20.1 mm; 24°54'35"N X 81°13'33"W, 4.3 m; *Fish Hawk* Sta. 7384; USNM 104478. – 1 ovig. ♀, 18.5 mm; 24°44'N X 82°02'W, 16.4-12.8 m; *Silver Bay* Sta. 78, USNM 104492. – 2 ♂, 18.9-14.1 mm; Tortugas Control Area, Station H, 16.4 m; FSBC I 6510. – 1 ♂, 15.6 mm; Tortugas Control Area, Station J, 16.4 m; FSBC I 6511. – 1 ♂, 16.0 mm; Tortugas Control Area, Station B, 21.3 m; FSBC I 6438. – 1 ♂, 14.3 mm, 1 ovig. ♀, 19.9 mm; Tortugas Control Area; FSBC I 3277. – 2 ovig. ♀, both 17.3 mm; Tortugas Control Area; FSBC I 3278. – 2 ♂, 14.5-13.0 mm; Dry Tortugas Buoy Area; USNM 102000. – 1 ovig. ♀, 15.7 mm; Tortugas shrimp grounds, 32.9 m; R. B. Manning; USNM 104499. – BAHAMAS: 1; Little Bahama Bank, 7.3-9.1 m; Marine Laboratory, University of Miami; USNM 104500. – PUERTO RICO: 1 ♀, 10.3 mm; 18°03'N X 67°18'W, 21.9-25.6 m; *Oregon* Sta. 5456; USNM 127991. – 1 ♀, 15.3 mm; dredged in front of docks in Mayaguez harbor; G. L. Warmke; Department of Marine Sciences, University of Puerto Rico. – VENEZUELA: 1 ♀, 13.6 mm; 12°16'N X 71°08'W, 20.1 m; *Oregon* Sta. 5680; USNM 127992.

Scyllarus chacei Holthuis

Figure 10

Scyllarus gundlachi A. Milne-Edwards, 1880, p. 64 (not *S. gundlachi* von Martens, 1872, p. 123).

Scyllarus americanus Rathbun, 1901, p. 97 (in part); Hay & Shore, 1918, p. 399, pl. 28, fig. 2; Bouvier, 1925, p. 447, pl.7, fig. 3 (in part); Boone, 1930, p. 84, pl. 23, fig. A; Schmitt, 1935, p. 174, fig. 39 (in part); Springer & Bullis, 1956, p. 14; Holthuis, 1959, p. 126 (in part); Bullis & Thompson, 1965, p. 9 [not *S. americanus* (Smith, 1869) p. 119].

Scyllarus chacei Holthuis, 1960, p. 152, 1969, p. 157; Harada, 1962, p. 109; Williams, 1965, p. 95-96, fig. 74; Robertson, 1968a, p. 82.

Diagnosis. Pregastric tooth of carapace broadly rounded, entire; gastric and cardiac teeth blunt, elevated, incised; two, occasionally three, distinct parallel grooves between posterior marginal

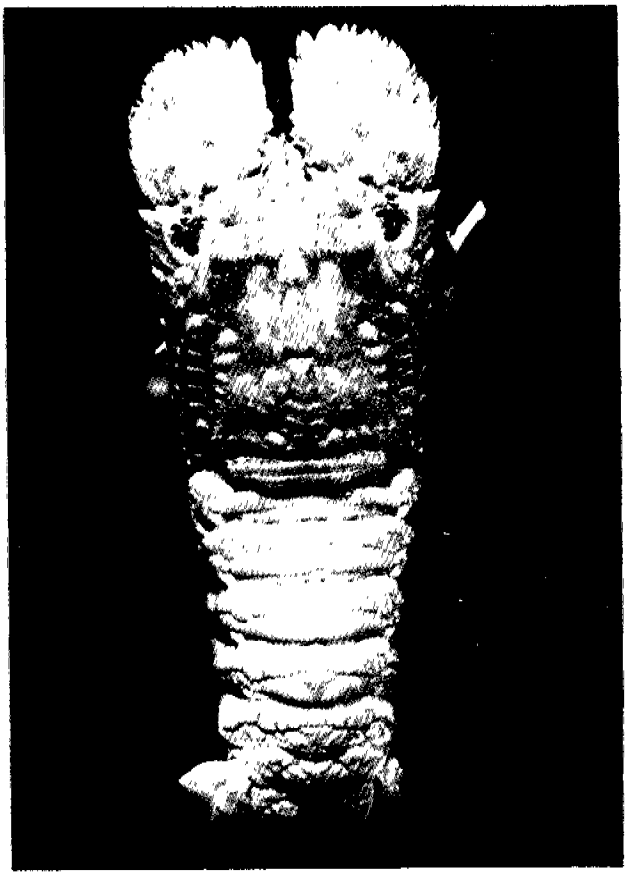


Figure 10. *Scyllarus chacei* ♀: CL = 24.2 mm; FSBC I 574.

groove and posterior margin of carapace; slight midventral elevation on fifth sternal plate only; first to fourth abdominal segments with very shallow, broad median notch in posterior margin; posterior margin of fifth segment without notch or median spine; fourth abdominal segment not elevated in midline; pleura of fourth segment rounded laterally.

Description. Williams (1965: 95-96) has presented an excellent description of adults of this species. Robertson (1968a) has obtained postlarvae through metamorphosis of phyllosomes taken in plankton tows. He was unable to separate them from postlarvae of *Scyllarus americanus.* His description of *S. americanus* postlarvae (1968b: 322-325) is generally applicable to *S. chacei* postlarvae as well. Differences in size and pleopod setation which may separate postlarvae of these two species are discussed on page 46.

Type Locality: North-northwest of the mouth of the Marowijne River, about 20 miles off the coast of Suriname.

Range: Off Cape Hatteras, North Carolina, through the Gulf of Mexico and Caribbean Sea to off Cape Sao Roque, Brazil; 11 to 329 meters.

Material Examined: NORTH CAROLINA: 1; 35°05'N X 75°09'W, 183 m; *Combat* Sta. 370; USNM 105667. – 1; 35°05'N X 75°09'W, 183 m; *Combat* Sta. 370; USNM 105920. – 1; 34°37'30"N X 75°39'45"W, 62 m; *Albatross* Sta. 2604; USNM 104462. – 1; 34°32'00"N X 76°12'00"W, 40 m; *Albatross* Sta. 2608; USNM 11247. – 2; 34°11'N X 76°18'W, 40 m; *Pelican* Sta. 187-2; USNM 104442. – 1; 34°06.5'N X 76°30.5'W, 42 m; *Pelican* Sta. 192-6; USNM

104441. – SOUTH CAROLINA: 1 ♀; 32°37'N X 78°53'W, 33 m; *Combat* Sta. 169; USNM 101322. – 4; 32°34'N X 79°05'W, 35 m; *Pelican* Sta. 194-10; USNM 104450. 2 ♀ (1 ovig.), 2 ♂; southeast of Edisto River sea buoy, 33-42 m; C. E. Dawson; USNM 101919.– GEORGIA: 1; 31°40'N X 79°55'W, 38 m; *Pelican* Sta. 179-9; USNM 104452. – 2; 31°28.5'N X 79°46'W, 46 m; *Pelican* Sta. 179-4; USNM 104437. – 1; 31° 23.5'N X 80 °04.5'W, 40 m; *Pelican* Sta. 178-18; USNM 104447. – 2; 31°20.5'N X 80°35.5'W, 27 m; *Pelican* Sta. 197-4; USNM 104440. – 2; 31°16.5'N X 80°27'W, 33 m; *Pelican* Sta. 197-5; USNM 104453. – 2; 31°13'N X 80°18'W, 37 m; *Pelican* Sta. 197-6; USNM 104439. – 5; 31°09'N X 80° 09'W, 42 m; *Pelican* Sta. 197-7; USNM 104448. – 6; 30°58.5'N X 80°10.5'W, 40 m; *Pelican* Sta. 198-2; USNM 104444. – 2; 30°52'N X 80°37.5'W, 31 m; *Pelican* Sta. 198-5; USNM 104445. – EAST FLORIDA: 2; 30°45'N X 80°45'W, 25 m; *Pelican* Sta. 177-4; USNM 104451. – 2 ♀, 1 ♂; 30°41'N X 80°16'W, 42 m; *Bowers* Sta. 37; USNM 101320. – 1; 30°31'N X 80°36'W, 35 m; *Pelican* Sta. 200-10; USNM 104446. – 1; 30°30'N X 80°28.9'W, 38 m; *Pelican* Sta. 176-11; USNM 104436. - 6 ♀ (4 ovig.), 5 ♂; 30°25'N X 80°20'W, 46 m; *Bowers* Sta. 34; USNM 99457. - 2 ovig. ♀, 1 ♂; 30°14'N X 80°16'W, 73 m; *Bowers* Sta. 32; USNM 99700. – 1 ♂; 30°11'N X 81°02'W, 24 m; *Pelican* Sta. 32; USNM 99698. 2; 30°06.5'N X 80°23.5'W, 48 m; *Pelican* Sta. 201-1; USNM 104443. – 1 ovig. ♀; 30°06'N X 80°19'W, 55 m; *Bowers* Sta. 31; USNM 99456. – 1 ovig. ♀; 30°04'N X 80°23'W, 46 m; *Bowers* Sta. 30; USNM 99699. – 3 ♂; 29°52'N X 80°11'W, 329 m; *Combat* Sta. 119; USNM 101321. -- 1; 29°33'N X 80°25'W, 35 m; *Silver Bay* Sta. 1820; USNM 106022. – 1 juv.; 29°03'N X 79°59'W, 320 m; *Pelican* Sta. 68; USNM 127995. - 1; off Palm Beach, 55 m; Thompson and McGinty; USNM 104460. – 1; off Miami, 18-73 m; J. B. Henderson; USNM 104464. – 2 ovig. ♀, 16.9-17.1 mm, 1 ♂, 15.7 mm; off Key West, 82 m; *Albatross* Sta. 2318; USNM 9479. – WEST FLORIDA: 1 ♂, 10.6 mm; 7 miles south of Dry Tortugas, 37 m; W. L. Schmitt; Sta. 7-30; USNM 104465. – 2 ♂, 15.2-15.7 mm; channel between White Shoal and Loggerhead Key, Dry Tortugas, 17 m; W. L. Schmitt; Sta. 6-31; USNM 104466. – 1 ♂, 15.4 mm; 30 miles northeast of Loggerhead Key, Dry Tortugas, 35 m; G. H. Eubank; USNM 99920. – 1 ovig. ♀, 24.2 mm; 1 ♂, 19.3 mm; 24°50'N X 83°05'W, 55 m; FSBC I 574. – 1; 25°00'31"N X 82°40'00"W, 38 m; *Grampus* Sta. 5052; USNM 22800. – 1 ovig. ♀, 19.1 mm, 2 ♂, 18.7-20.5 mm; 25°10'N X 83°05'W, 55 m; FSBC I 572. – 3 ♀ (2 ovig.), 10.6-14.7 mm; 2 ♂, 10.1-10.9 mm; 25°12'N X 82°41'W, 45 m; FSBC I 584. - 1 ovig. ♀, 20.9 mm; 25°26'N X 83°10'W, 54 m; FSBC I 566. – 2 ♀ (1 ovig.), 13.1-13.2 mm; 25°30'N X 83°51'W, 42 m; FSBC I 609. – 1; 25°34'N X 83°07'W, 55 m; *Grampus* Sta. 5078; USNM 23274. – 1 ♀, 14.6 mm; 25°35'N X 82°51'W, 46 m; FSBC I 599. – 1; 25°44'32"N X 82°48'15"W, 44 m; *Grampus* Sta. 5085; USNM 22801. – 1; 26°08'N X 83°22'W, 60 m; *Grampus* Sta. 5102; USNM 22802. – 1 ♀; 26°17.8' – 26°18.7'N X 83°59.2'W, 40 m; R. H. Stewart; Sta. D-13; USNM 104461. – 1 ovig. ♀, 23.3 mm; 26°24'N X 83°27'W, 71 m; FSBC I 482. – 172 specimens from regular Hourglass collections (Table 5, Figure 21). – 1 ♂, 21.6 mm; 80 miles west of Ft. Myers, 53-55 m; FSBC I 3283. – 1 ♀, 12.9 mm; 27°03'N X 83°14'W, 40 m; FSBC I 1200. – 1 ovig. ♀, 10.7 mm; 27°06'N X 83°15'W, 37-39 m; FSBC I 1769. – 1 ovig. ♀, 22.9 mm, 1 ♂, 18.5 mm; 27°19'N X 83°50'W, 55 m; FSBC I 3057. – 1 ♂, 22.0 mm; 27°30'N X 84°14'W, 67 m; *Oregon* Sta. 937; USNM 96358. – 1 ♀, 12.1 mm, 1 ♂, 11.6 mm; 35 miles west of Egmont Key, 30 m; FSBC I 3286. 1 ovig. ♀, 18.0 mm; 27°45'N X 84°10'W, 46 m; FSBC I 2272. – 1 ♂; 27°47'N X 83°56'W, 51 m; *Oregon* Sta. 4087; USNM 127998. – 1 ♀, 17.1 mm; 28°09'N X 83°50'W, 37 m; *Silver Bay* Sta. 54; USNM 101323. – 1 ovig. ♀; 28°24'N X 84°08'W, 18 m; *Hernan Cortez* Sta. 19; USNM 127993. – 1 ovig.♀, 22.0 mm; 28°40'N X 84°44'W, 53 m; FSBC I 552. – 1; 28°43'30"N X 84°37'00"W, 44 m; *Albatross* Sta. 2407; USNM 9811. – 1 ♀; 25.8 mm; 28°44'N X 85°01'W, 46 m; *Oregon* Sta. 728; USNM 94440. – 2 ovig. ♀, 15.0-16.6 mm, 2 ♂, 12.2-14.1 mm; 28°50'N X 85°06'W, 64 m; *Oregon* Sta. 896; USNM 96357. – 1 ♀, 13.8 mm; 28°50'N X 85°06'W, 64 m; *Oregon* Sta. 896; USNM 97441. – 1 ♂, 11.6 mm; 29°12'N X 84°33'W, 31 m; *Oregon* Sta. 898; USNM 97442. – 1 ovig. ♀, 21.9 mm; 29°02'N X 84°43'W, 35-37 m; *Silver Bay* Sta. 88; USNM

101324. – 1 ovig. ♀, 16.7 mm; 29°08'N X 85°00'W, 31 m; *Pelican* Sta. 156-2; USNM 104449. – 1; 29°11'30"N X 85°29'00"W, 48 m; *Albatross* Sta. 2374; USNM 9637. – 2; 29°14'00"N X 85°29'15"W, 46 m; *Albatross* Sta. 2373; USNM 9625. – 1; 29°15'30"N X 85°29 30"W, 49 m; *Albatross* Sta. 2372; USNM 9617. – 1; 29°16'30"N X 85°32'00"W, 46-49 m; *Albatross* Sta. 2369-2374; USNM 9600. – 1 ovig. ♀, 15.0 mm; 30°07'N X 86°01'W, 26 m; *Oregon* Sta. 1697; USNM 104432. – 1 ♀, 15.2 mm; 30°13'N X 86°10'W, 27 m; *Pelican* Sta. 151-2; USNM 104435. – ALABAMA: 1 ♀, 16.9 mm; 29°35'N X 88°10'W, 40 m; *Oregon* Sta. 1666; USNM 101319. – 1 ♂, 15.0 mm; 29°36'N X 87°29'W, 66 m; *Pelican* Sta. 137-2; USNM 104455. – LOUISIANA: 1 ♀, 14.8 mm; 28°46'N X 93°25'W, 27 m; *Pelican* Sta. 100-3; USNM 104454. – 2 ♀, 15.6-17.0 mm; 28°26.5'N X 93°27'W, 49 m; *Pelican* Sta. 101-1; USNM 104438. – MEXICO: 1; Campeche snapper banks; Jos. Lee; USNM 44321. – 1 ♀, 7.7 mm; 21°47'N X 88°10'W, 18 m; FSBC I 6974. – GULF OF MEXICO: 1 ovig. ♀, 15.5 mm; *Albatross* collection; USNM 104463. – BAHAMAS: 1 ♂, 13.2 mm; 23°44'-23°55'N X 80°25.8'-80°30.5'W, 11-24 m; FSBC I 6519. – 1 juv; 20°53'N X 73°42'W, 183 m; *Silver Bay* Sta. 3496; USNM 127994. – PUERTO RICO: 1 ♂; 18°06.5'N X 67°23'W, 22-27 m; *Oregon* Sta. 5458; USNM 128001. – 1 ♂; 18°03'N X 67°18'W, 22-26 m; *Oregon* Sta. 5456; USNM 127996; (with 1 *S. americanus*). – 1; north of Vieques Island, 27 m; *Fish Hawk* Sta. 6091; USNM 24621. – VIRGIN ISLANDS: 2; off St. Thomas; *Oregon* Sta. 5000; USNM 128000. – HONDURAS: 1; 16°05'N X 82°05'W, 44 m; *Oregon* Sta. 1938; USNM 104430. – 2; 15°30'N X 81°04'W, 29 m; *Oregon* Sta. 1892; USNM 104434. – PANAMA: 3 ♀; 09°43'N X 79°20'W, 95 m; *Oregon* Sta. 5739; USNM 128002. – 2 ♀; 08°40'N X 77°10'W to 08°43'N X 77°11'W, 60-66 m; *Atlantis* Sta. 254-3; USNM 105022. – COLOMBIA: 1; 12°12'35"N X 72°10'45"W, 24 m; *Velero III* Sta. A-13-39; USNM 104456. – 3; 12°11'55"N X 72°11'30"W, 40 m; *Velero III* Sta. A-14-39; USNM 104457. – 2; 12°24'37"N X 71°47'25"W, 17 m; *Velero III* Sta. A-15-39; USNM 104458. – VENEZUELA: 1 ♀, 1 ♂; 10°44'N X 66°09'W, 73 m; *Oregon* Sta. 4466; USNM 127999. – 2; 09°22'N X 59°23'W, 91 m; *Oregon* Sta. 2221; USNM 104431. – GUYANA: 5; 08°31'N X 58°37'W, 84-88 m; *Oregon* Sta. 2232; USNM 104428. – 3; 07°45'N X 57°34'W, 55-64 m; *Oregon* Sta. 2248; USNM 104433. – 3; 07°55'N X 57°30'W, 82 m; *Oregon* Sta. 2000; USNM 104429. – 27 ♀ (17 ovig.), 19 ♂; 07°40'N X 57°34'W, 49-55 m; *Oregon* Sta. 2249; USNM 103498. – SURINAME: 10; "off Suriname"; *Coquette*; USNM 103205. – 1 ♂; 08°20'N X 58°30'W, 42-48 m; *Oregon* Sta. 2234; USNM 127997. – 1; "off Suriname," 48 m; *Coquette* Sta. 287; USNM 103210. – 2; 06°47'N X 55°40'W, 46 m; *Coquette* Sta. 283; USNM 103209. – 4; 06°46'N X 55°36.5'W to 06°46.5'N X 55°38'W, 46 m; *Coquette* Sta. 281-282; USNM 103207. – 1 ovig. ♀; 06°50'N X 55°34'W, 51 m; *Oregon* Sta. 2335; USNM 103499. – 1; 06°44'N X 55°33'W, 46 m; *Coquette* Sta. 279; USNM 103211. – 2; 06°50'N X 55°22'W, 53 m; *Coquette* Sta. 334; USNM 103208. – 3; 06°49'N X 55°21'W to 06°47'N X 55°18'W, 49-53 m; *Coquette* Sta. 337; USNM 103206. – 1; 06°52'N X 54°53'W, 51 m; *Coquette* Sta. 33; USNM 103212. – BRAZIL: 1 ovig. ♀, 1 ♂; 01°10'N X 46°52'W, 55 m; *Oregon* Sta. 2088; USNM 101644. – 1; off Cape Sao Roque, 37 m; *Albatross* Sta. 2758; USNM 23328. – NO COLLECTION. DATA: 1; USNM 22803. – 1; from Carnegie Institute; USNM 104459.

Scyllarus depressus (Smith)

Figure 11

Arctus depressus Smith, 1881, p. 429; Bouvier, 1917, p.115, 1925, p. 451, pl. 8, fig. 2; Robertson, 1968a, p. 73, 1968b, p. 325.

Scyllarus arctus paradoxus Rathbun, 1900, p. 309 (in part); (not *Scyllarus arctur* var. *Paradoxus* Miers, 1881).

Scyllarus depressus Bouvier, 1915a, p. 291; Harada, 1962 , p. 109.

Scyllarus arctus Springer & Bullis, 1956, p. 14; Bullis & Thompson, 1965, p. 9; [not *Cancer* (=*Scyllarus*) *arctus* Linne].

Scyllarus nearctus Holthuis, 1960, p. 151; Harada, 1962, p. 109, Williams, 1965, p. 97-98, fig. 76; Robertson, 1968a, p. 50, fig. 37, 1968b, p. 329.

Figure 11. *Scyllarus depressus* ♀: CL = 25.8 mm; FSBC I 5869.

Diagnosis. Pregastric, gastric, and all lateral teeth of carapace well defined, sharp, not incised; cardiac tooth low, bilobed; midventral elevation on fifth sternal plate only; first to fourth abdominal segments with deep, acute median notch in posterior margin, less developed in fourth segment than in first three; posterior margin of fifth segment without notch or median spine; a slight median ridge on second through fifth segments; pleura of fourth segment sharply rectangular or acute laterally.

Description. Williams (1965: 97-98) provides a very good description of adults of this species under the synonym *Scyllarus nearctus* Holthuis.

Postlarva (Figure 12). Carapace smooth, slightly broader than long, broadest portion near middle. Rostrum a short, blunt, forwardly directed tubercle; pregastric tooth absent; gastric tooth low, blunt, entire; cardiac tooth low, bilobed; about nine pairs of minute tubercles extending in two arcs from cardiac tooth toward posterior ends of branchial ridges; about 16 low teeth on inner carina of branchial ridge, seven such teeth on outer carina; posterior corners of carapace with about eight tubercles; cervical groove shallow but distinct; a strong, toothed ridge extending from cervical groove to inner orbital angles, ending in two large blunt teeth at orbits. Front emarginate, a forwardly directed protrusion about midway between rostrum and each inner orbital angle. Orbits deep, subrectangular, lined with cilia. Anterolateral spines of carapace acute, forwardly directed; lateral margins arcuate, serrate, with two deep notches, first notch slightly behind orbits, second (cervical) notch almost even with or slightly behind anterior end of branchial ridge. Posterior marginal groove shallow but distinct; about eight acute spines visible through transparent exoskeleton on each side of midline in region between posterior marginal groove and posterior margin; notch at midline of posterior margin wide, subtriangular.

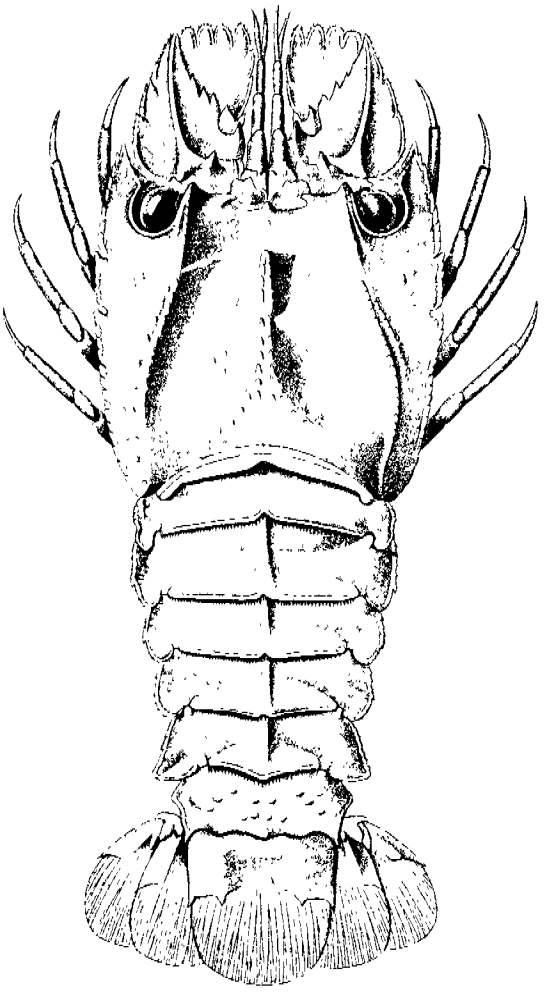


Figure 12. *Scyllarus depressus* postlarva (after Bouvier, 1925).

Antennae broad, flat as in adult *Scyllarus*, with sparsely scattered setae dorsally. Anterior margin of distal segment divided into five or six minutely serrate lobes; outer lobes rounded, becoming progressively sharper toward inner margin of segment; lobes and lateral margins fringed with long setae. Penultimate segment small, broader than long, with an acute, forwardly directed spine forming the apex; outer margin with three small spines anteriorly, two large spines on posterior half; a distinct oblique ridge extending from anterolateral spine to near center of posterior border; inner margin with many small teeth anteriorly; posterior edge of inner margin folded upward, with three tubercles, anterior one long, slender, directed forward. Proximal segment subtriangular, anterior margin broadest, a large rounded spine at center of anterior border; outer corner sharply rounded, two sharp spines on posterior margin near outer corner; inner corner sharp, directed forward; a low, spine-like tubercle about midway between inner corner and central spine of anterior margin.

Antennules slightly longer than antennae. Inner flagellum shorter than outer, former with dense setae on distal half, latter more slender, with scattered setae along entire length. Proximal segment of peduncle stout, compressed at middle, with long stiff hairs on anterior half dorsally and

along inner lateral margins; an arc of very short hairs near inner margin of posterior quarter dorsally; coxi of antennules with a blunt spine at center of anterior margin, a smaller spine about midway from central spine to inner anterior corners.

Anterior extremity of sternum of two well-separated lobes; a wide, low midventral elevation at posterior margin of fifth sternal plate; posterior corners produced as single, acute spines.

Surface of abdominal segments generally smooth, shallowly sulcate transversely; a distinct carina at midline of segments two through five; sixth segment faintly squamose, without carina. Segments one through four with a deep subtriangular notch at midline of posterior margin; posterior margin of fifth segment rounded, without notch or spine at midline; sixth segment with an acute spine at each posterior corner, a blunt protrusion directed posteriorly at midpoint of posterior margin, another such protrusion about halfway between midpoint and each posterior corner. A very sharp, posteriorly directed spine at tips of abdominal pleura two, three, and four; posterior margins of these pleura faintly serrate; pleura of segment five rounded laterally, posterior margin minutely serrate.

Hardened portion of telson with two dorsal tubercles on each side of midline, outer pair larger than inner; posterior margin of this portion with four large subequal spines, the more acute outer pair at the posterior corners, inner pair about equidistance from posterior corners and midline; soft portion of telson rounded at corners, straight at posterior margin, fringed with short setae. Rami of uropods faintly serrate on outer margins, a blunt tooth at each outer distolateral corner; soft portions ovate, fringed like telson.

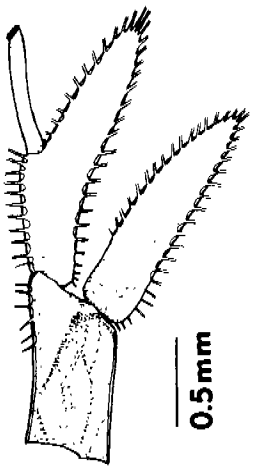


Figure 13. *Scyllarus depressus* postlarval pleopod 1.

Pleopods (Figure 13) biramous; endopods and exopods of approximately equal length, fringed with long, plumose setae; endopods with a rod-like appendix interna which entends almost to distal tip of endopod; each appendix interna with dense cluster of cincinnuli at tip; basipods shorter than endopods and exopods, subtruncate distally, with six plumose setae on inner distolateral margin of first and second, five such setae on third, and four on fourth.

Type Locality: Off Martha's Vineyard, Massachusetts, in 157.3 m.

Range: Off Martha's Vineyard; off Cape Hatteras and east Florida through Gulf of Mexico to State of Sao Paulo, Brazil; 29 to 263 m.

Material Examined: MASSACHUSETTS: 1 postlarva, off Martha's Vineyard, 157 m; *Fish Hawk* Sta.872; USNM 35392 (Holotype of *Artcus depressus* Smith). – VIRGINIA: 1 postlarvae, 5.7 mm; off Cape Charles, 37°07'00"N X 74°34'30"W, 117 m; *Albatross* Sta. 2421; USNM 104483. – NORTH CAROLINA: 1 postlarva; 58 m; *Albatross* Sta. 2605; USNM 22804. – 5; 35°08'30"N X 75°10'00"W, 90 m; *Albatross* Sta. 2596; USNM 11237. – 2 ♀, 3 ♂; 35°05'N X 75°09'W, 183 m; *Combat* Sta. 370; USNM 101326. – 1 ♂; 33°56.5'N X 76°27'W.82-113 m; *Silver Bay* Sta. 3339; USNM 128009. – SOUTH CAROLINA: 1 ♀, 1 ♂; 33°04'N X 78°12'W, 29 m; *Silver Bay* Sta. 2263; USNM 128007. – EAST FLORIDA: 1 ♀; 29°40'N X 80°16'W, 65-87 m; *Silver Bay* Sta. 4451; USNM 128006. – 1 ♀; 29°19'N X 80°13'W; 70-71 m; *Silver Bay* Sta. 3431; USNM 128010. – 2 ♂; 28°52'N X 80°05'W, 119 m; *Combat* Sta. 90; USNM 101325. – 1 ovig. ♀; 28°30'N X 80°02'W, 68-75 m; *Silver Bay* Sta. 3704; USNM 128011. – 1 ♂; 27°59'N X 80°01'W, 73 m; *Silver Bay* Sta. 5107; USNM 128012. – 1 postlarva; off Palm Beach, 183-229 m; Thompson & McGinty; USNM 104495. – 1; off Palm Beach; 55 m; T. L. McGinty; USNM 104507. – 1; off Palm Beach, 55-73 m; Thompson & McGinty; USNM 104508. – 2; 2.1 miles SE of Fowey Rock Light, 82 m; *Fish Hawk* Sta. 7511; USNM 104510. – 2 ♀, 2 ♂; 25°16'N X 80°07'W, 118 m; *Combat* Sta. 457; USNM 101338. – 1 ovig. ♀, 1 ♂; 25°01'N X 80°19.5'W, 82-84 m; *Silver Bay* Sta. 2369; USNM 128008. – 1 ♀, 19.8 mm; 1 ♂, 22.0 mm; 24°25'45"N X 81°46'00"W, 82 m; *Albatross* Sta. 2318; USNM 23273. – 1 postlarva; off Western Dry Rocks, 263 m; J. B. Henderson; USNM 104497. – WEST FLORIDA: 2 ♀, 20-22 mm, 1 ♂, 15.9 mm; south of Dry Tortugas, 100-106 m; W. L. Schmitt; Sta. 64-32; USNM 104501. – 2 ♂, 11.9-17.4 mm; south of Dry Tortugas, 73 m; W. L. Schmitt; USNM 104505. – 2 ♀, 15.2-17.6 mm; 2 ♂, 16.0-18.9 mm; south of Dry Tortugas, 64-73 m; J. W. Mills; USNM 104509. – 2 ♀, 13.4-18.4 mm, 1 ♂, 16.0 mm; Dry Tortugas, 90 m; W. L. Schmitt; Sta. 31-32; USNM 104504. – 1 ♀, 21.2 mm; Dry Tortugas, 84-91 m; W. L. Schmitt; Sta. 62-32; USNM 104502 – 1 ♀, 16.8 mm; Dry Tortugas, 84-91 m; W. L. Schmitt; Sta. 62-32; USNM 104503 (Holotype of *S. neartus* Holthuis 1960). – 1 ♂, 12.0 mm; Dry Tortugas, depth not recorded; W. H. Longley; USNM 104587. – 1 ♂, 13.1 mm; 24°24'N X 82°55'W, 62 m; *Oregon* Sta. 1004; USNM 97443. – 1 ♀, 17.0 mm; 1 ♂, 19.0 mm; 25°55'N X 83°53'W, 113 m; *Oregon* Sta. 33; USNM 91134. – 13 specimens, 6.4-25.8 mm; 55-73 m (Hourglass collections, Table 6). – 1 ♀; 26°25'N X 83°52'W, 91 m; *Hernan Cortez* Sta. 159; USNM 128005. - 1 ♂, 17.0 mm; 28°42'30"N X 85°29'00"W, 161 m; *Albatross* Sta. 2403; USNM 9773. – 1 postlarva; 28°42'30"N X 85°29'00"W, 161 m; *Albatross* Sta. 2403; USNM 23327. – 2 postlarvae; 110 m; *Albatross* Sta. 2404; USNM 9780. – 2 ♂, 11.8-15.0 mm; 28°50'N X 85°06'W, 64 m; *Oregon* Sta. 896; USNM 96359. – 2 ♀; 12.8-14.1 mm; 28°55'N X 85°22'W, 73 m; FSBC I 551. – 1 ♀, 19.2 mm, 2 ♂, 12.0-16.2 mm; 29°50'N X 86°30'W, 91 m; *Oregon* Sta. 994; USNM 96360. - 1 ovig. ♀, 15.0 mm; Pensacola, depth not recorded; Silas Stearns; USNM 13991. – 1 ♀, 24.7 mm; west coast of Florida, depth not recorded; FSBC I 4632. – LOUISIANA: 1 ♀; 17.0 mm; 29°15'05"N X 88°18'W, 91 m; *Oregon* Sta. 70; USNM 91104. – VENEZUELA: 1 ♂; 10°50'N X 66°55'W, 97 m; *Oregon* Sta. 4461; USNM 128013. – TRINIDAD: 1 ♂; 11°14'N X 60°51'W, 70 m; *Oregon* Sta. 5023; USNM 128014. – SURINAME: 14; 07°25'N X 54°35'W, 137-146 m; *Oregon* Sta. 2289; USNM 104511. – BRAZIL: 1; 02°40'N X 47°56'W, 115 m; *Oregon* Sta. 2065; USNM 104512. 1; Ilba de Sao Sebastiao, State of Sao Paulo, depth not recorded; H. Luederwalt; USNM 104506.

Remarks. Robertson (1968b: 327-329) has discussed the probability that the postlarval specimen of 16 mm assigned to *Scyllarus americanus* by Bouvier (1925) is actually a postlarva of *Scyllarus nearctus* Holthuis. In his dissertation (1968a: 72-78, fig. 37) he combined positive larval and post-

larval evidence with comparisons of Bouvier's and Smith's material to show convincingly that *Scyllarus depressus* (Smith), *S. nearctus Holthuis*, and the postlarva described by Bouvier (1925) from Sand Key are the same species, noting (p. 77) that "unfortunately, under the present international rules of nomenclature Smith's name *depressus*, although founded on an immature form, would have priority over *nearctus* for the species."

I have compared postlarvae identical to the one described by Bouvier with adult *S. faxoni* Bouvier and *S. nearctus* and am in agreement with Robertson that they should be assigned to *S. nearctus*. Often characters present in adult scyllarids are either over-emphasized or, conversely, highly reduced in postlarvae. However, comparison of adults of the two above species with these postlarvae did produce some seemingly definitive differences. There is a midventral tubercle on only the fifth sternal plate of the postlarvae, agreeing with *S. nearctus* but not with *S. faxoni*, which has a midventral tubercle on each of the five sternal plates; the posterior margin of the fourth segment of both the postlarvae and *S. nearctus* have a prominent notch at midline, while the same region on *S. faxoni* lacks a notch, being extended to the rear at this point; the posterior margins of the fifth segments of the postlarvae and *S. nearctus* are broadly rounded, being smooth in *S. nearctus* but showing a very fine, shallow incision in the postlarvae, whereas *S. faxoni* has a prominent posteriorly directed spine at this point; there are four acute, subequal spines on the posterior margin of the hardened portion of the telson of the postlarvae and *S. nearctus*, the outer spines being located at the posterior corners; the outer spines on *S. faxoni* are of approximately the same size and acuteness as those of *S. nearctus* but the inner two spines are much shorter and more blunt, appearing as posteriorly directed tubercles.

In support of speculation by Robertson (1968a: 76-77) that minor damage to the holotype of *Arctus (=Scyllarus) depressus* Smith may account for its lacking the spiniform tips on abdominal pleura 2, 3, and 4 which Bouvier, Robertson, and I have found on subsequent specimens, I have examined one specimen (USNM 104497) which has spiniform pleural tips on the left side, but on the right side such a tip is present only on pleuron 2. Pleura 3 and 4 are rounded as described by Smith. Microscopic examination revealed that these tips had been broken off. I must concur with Robertson that *S. depressus* Smith is the proper name for the species recently designated *S. nearctus* Holthuis.

Scyllarus faxoni Bouvier

Figure 14

Arctus americanus A. Milne-Edwards, 1880, p. 64 (not *A. americanus* S. I. Smith, 1869, p. 119).

Scyllarus faxoni Bouvier, 1917, p. 106 (*nomen nudem*), 1925, p. 444, pl. 7, fig. 2; Holthuis, 1946, p. 88; Springer & Bullis, 1956, p. 14; Harada, 1962, p. 109; Bullis & Thompson, 1965, p. 9.

Diagonosis. Pregastric tooth of carapace blunt, broadly rounded; gastric tooth sharp, not incised; cardiac tooth well developed, minutely incised; a midventral tubercle on each of the five sternal plates; first to third abdominal segments with moderately deep, narrow median notch in posterior margin; fourth segment with minute median incision in posterior margin; fifth segment with strongly produced, acute median spine on posterior margin; a distinct median carina on second through fifth abdominal segments; pleura of fourth segment acute laterally.

Description. Carapace squamose dorsally, smooth below, densely ciliate between squames, especially in cervical, branchial and other grooves. Rostrum short, tubercle-like; pregastric tooth above it larger, broadly rounded; gastric tooth acute, higher than pregastric; cardiac tooth elevated, blunt, minutely incised; all four preceding teeth directed forward. Cervical groove deep, well-defined.

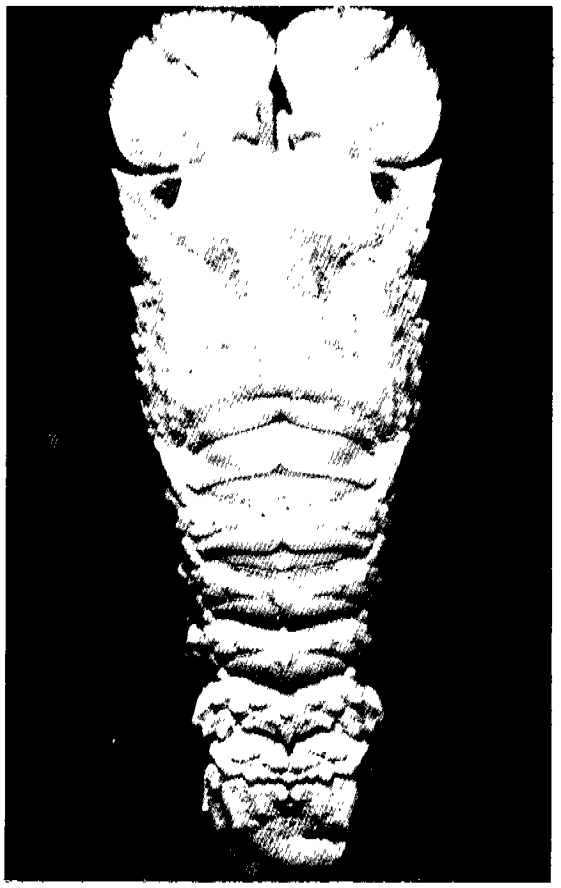


Figure 14. *Scyllarus faxoni* adult ♂: CL = 16.3 mm; USNM 98654.

Lateral ridges ending at orbits in an acute, forwardly directed spine. Front emarginate, a small projection about halfway between rostrum and orbit. Orbits deep, lined at borders with cilia; inner orbital angles with two subequal spines; outer orbital angles with a single small spine. Anterolateral corners of carapace with a large, acute, forwardly directed spine; lateral borders with a deep narrow notch behind eye, another slightly behind anterior end of branchial ridge. Posterior marginal groove deep, narrow; area between posterior marginal groove and posterior margin of carapace irregularly sculptured; posterior margin of carapace with a moderately shallow, subtriangular notch in midline.

Antennae broad, flattened, somewhat ciliate, edges lined with dense feathered setae. Anterior edge of distal article notched into six or seven well separated lobes, rounded tips of lobes at outer margin becoming progressively sharper toward inner margin, inner lobe smallest, quite sharp, outer lobe broadest, subtruncate. Penultimate article short, two short spines near outer anterior corner, a large blunt spine near inner corner dorsally. Second segment largest, roughly triangular with apex-formed by strong, anterolateral spine; outer lateral margin of three large, acute spines; inner margin serrate, a large blunt tooth near center; two oblique ridges extend from outer margin to posterior border. Proximal article short, broad, a large spine near midpoint of anterior edge, a smaller one at outer angle.

Antennules slender, cylindrical, slightly longer than antennae; antennular peduncles swollen distally, a blunt forwardly directed tooth at upper distal end.

Sternum broad, covered with short cilia; a prominent midventral tubercle on each of the five sternal plates; anterior extremity of sternum straight, unnotched.

Legs slender, first pair stouter than others, cilia on dorsal surface of meri of all legs increasing in length and density from first to fifth pairs, being hardly evident in first two pairs; dense cilia on underside of meri of all pairs. Dorsal side of propodi of third and fourth pairs with a dense carina-like ridge of sensory setae; a similiar group of setae on underside of propodi of first four pairs; propodus of fifth legs of females projecting forward at lower distal corner to form a finger which articulates with dactylus. Dactyli of third and fourth legs relatively short, with many sensory setae above and below; setae on dactyli of other legs generally confined to underside; tips of dactyli slender, corneous.

First three abdominal segments with a subtriangular notch at midline on posterior margin quite similar to notch at posterior margin of carapace. First abdominal segment smooth anteriorly, about four small squames on each side of midline on posterior half; a deep, transverse arborescent furrow separating the two halves; pleuron of first segment small, rough, lateral margin of three small, sublobate protrusions. Second through fifth segments with a distinct median carina incised posteriorly in second through fourth; arborescent furrows from anterior and posterior lateral corners intersecting near median carina; slender, triangular areas between furrows squamose, dorsal surfaces otherwise smooth; fifth segment with a prominent posteriorly directed spine at midpoint of posterior margin. Pleuron of second segment broad, tapering to an obtuse spine, faintly serrate on posterior margin; pleura of third and fourth segments tapering as second, but with a short, blunt spine in addition to low serration on posterior margins; pleuron of fifth segment obtusely angled laterally, two large, sharp spines on posterior margin; sixth segment squamose overall, a blunt spine at each posterior corner, a rounded tubercle at midline of posterior edge, another between midline and each posterior corner.

Telson with a very sharp, corneous-tipped spine at each posterior corner of hardened portion, a rounded tooth on posterior margin near each corner; one small and one large, low tubercle at each side of midline on central region of hardened portion; soft portion rounded at posterior corners, straight behind, fringed with short setae. Uropods ovo-elongate, fringed as telson; outer posterior corners of each ramus of uropods with a sharp, corneous tipped spine as on telson.

Postlarva. Unknown.

Type Locality: Blake station 167, off Guadeloupe, West Indies, 320 m.

Range: Caribbean coast of Costa Rica and Guadeloupe to northern Bahamas, 229 to 457 meters.

Material Examined: COSTA RICA: 1; off Tortuguero, 11°34'N X 83°07'W, 229 m; *Oregon* Sta. 1904; USNM 104516. – BARBUDA: 3 ♀; 17°38.5'N X 62°16'W, 329-338 m; *Oregon* Sta. 6699; USNM 128019. – ANGUILLA: 3 ♀ (2 ovig.); 18°10'N X 63°16'W, 338 m; *Oregon* Sta. 5916; USNM 128018. – PUERTO RICO: 1 ♂; off Aguadilla, 18°16'N X67°22'W, 274 m; *Silver Bay* Sta. 5193; USNM 128017. – CUBA: 6 ♂; 3 ♀; 22°50'N X 79°08'W, 366-412 m; *Oregon* Sta. 1344; USNM 128015. – 1 ♀; 22°50'N X 79°18'W, 412 m; *Oregon* Sta. 1345; USNM 101327. – 2; 22°55'N X 79°16'W, 439 m; *Oregon* Sta. 1341; USNM 104515. – 2 ♂; 2 ♀ (1 ovig.); 22°55'N X 79°27'W, 457 m; *Oregon* Sta. 1340; USNM 98654. – BAHAMAS: 2 ♂, 1 ♀; 25°10'N X 79°13'W, 457 m; *Combat* Sta. 446; USNM 101646. – 2 ♂; 25°13'N X 79°13'W, 366 m; *Silver Bay* Sta. 2477; USNM 128016. – 2 ♀ (1 ovig.); 27°27'N X 78°58'W, 329 m; *Combat* Sta. 235; USNM 101328. – 1 ♀; 27°28'N X 78°44'W, 393 m; *Combat* Sta. 237; USNM 101645.

Additional records: GUADELOUPE: 1; 320 m; *Blake* Sta. 167 (Bouvier, 1925). – BAHAMAS: 1 ♀; *Combat* Sta. 238; 27°30'N X 78°52'W, 421 m; (Bullis & Thompson, 1965).

DISCUSSION

FERTILIZATION

The process of fertilization varies among genera within the Palinuridae, being external in some and internal in others. Fielder (1964) demonstrated that fertilization is internal in the palinurid lobster *Jasus lalandei* (H. Milne-Edwards), a phenomenon that was suspected earlier by Von Bonde (1936). Smith (1959) and many others have described the process of fertilization in several species of *Panulirus*; in each description, the male deposits a putty-like spermatophore (called "tar" by local fishermen) on the sternum of the female, posterior to the genital apertures, sometime before the eggs are released. The spermatophore, initially soft and light in color, hardens and turns black. Eggs are said to be fertilized externally by sperm released from the spermatophore by the chela of the fifth legs of the female (Fielder, 1964).

Fertilization probably varies within the Scyllaridae as it does within the Palinuridae. Harada (1958), Prasad and Tampi (1960), Saisho and Nakahara (1960), Saisho (1962), Dotsu, Seno and Inoue (1966), Sims (1966), and Robertson (1968) have reported on phyllosomes hatched from ovigerous *Ibacus, Parribacus,* and *Scyllarus* held in the laboratory. Although none of these authors mention the presence of spermatophores on the ovigerous females, external fertilization need not be precluded. In fact, one female *Parribacus antarcticus* (FSBC I 765) bearing a spermatophore was captured by the author at Grand Cayman Island, West Indies, in August, 1965. The spermatophore was hard and black and ovigerous setae of the pleopods were long and well developed as described by Fielder (1964b:140) for mature animals, but no eggs or remnants of egg cases were present on these pleopods, indicating that the female had not yet spawned.

Dr. A. J. Provenzano, Jr. (personal communication) maintained in an aquarium a female *P. antarcticus* captured in the spring of 1969 in the Florida Keys. When captured, the lobster was bearing an external spermatophore and eggs. These eggs were viable but were cast off in the aquarium. Soon after, the lobster produced another mass of viable eggs.

No female *Scyllarides* or *Scyllarus* examined in this study showed any indication of having carried an external spermatophore. Robertson (personal communication) reports that one female *Scyllarus depressus* spawned viable eggs three times after capture, being isolated from all other lobsters during this period, and that no spermatophore was evident. This suggests the presence of an internal spermatophore in *Scyllarus* and is substantiated by the large number of other females captured without external "tar." The many *Scyllarides nodifer* collected without external spermatophores suggests that fertilization is also internal in that genus.

SPAWNING

One *Scyllarus chacei* and one *S. depressus* bearing new (bright yellow) eggs in late January 1967 were returned alive to our laboratory for observation. Development of the eggs of both species proceeded rapidly and a hatch of *S. chacei* phyllosomes was obtained 15 days after capture. Eleven days after capture the *S. depressus* dropped her eggs which were in a late stage of development (eyed stage) and would probably have hatched within a few days. Duration records of ovigerous scyllaridean lobsters held in the laboratory prior to hatching are: four days (Harada, 1958; advanced eggs of *Ibacus ciliatus*), about a week (Saisho and Nakahara, 1960; *Ibacus ciliatus*), ten days (Sims, 1966; *Scyllarus americanus*), two to three weeks (Robertson, 1968; three broods of recently deposited eggs of *S. americanus*). This data indicates that embryonic development in scyllarideans is rapid, probably seldom more than a month, and that the presence of ovigerous females may be considered an approximation of spawning time.

Duration of stage I phyllosomes of *S. americanus* reared in the laboratory by Robertson (1968b) ranged from three to six days. Spawning therefore can be considered nearly coincident with occurrence of first-stage phyllosomes in the plankton. Baisre (1966) reported first stage phyllosomes of *S. americanus* from inshore waters of Cuba in March, April, June, November, and December. The phyllosomes were decidedly less abundant in the last two months. Robertson (1968b) found stage I phyllosomes of *S. americanus* in February, March, April, May, and September when he re-examined collections reported earlier by Robinson and Dimitriou (1963 a, b).

Previous records of ovigerous western Atlantic Scyllaridae are scarce. Williams (1965) reports *Scyllarus americanus* from southern Florida in September, *S. chacei* from Florida in March, South Carolina in July, Suriname in August and September, and northeast Brazil in November. He reports ovigerous *S. nearctus* (=*S. depressus*) off North Carolina in June. Specimens reported by Williams were from the collection of the U. S. National Museum. Examination of this collection during the present study revealed further spawning records: *Scyllarus americanus* off south Florida in July and August, northwest Florida in February; *S. chacei* off Key West in January, and off northwest Florida in February, May, and July; *S. depressus* off east Florida in January and October. There are ovigerous *Scyllarus depressus* and *Scyllarides nodifer* from Pensacola, Florida, collected by Silas Stearns. Unfortunately, dates of collection were not noted. Ovigerous *Scyllarus faxoni* in the U.S. National Museum were collected off Anguilla and the Little Bahama Bank in February and off northern Cuba in July. Sims (1966b) reports gravid *S. americanus* in the St. Petersburg Area from February to May. Robertson (1968b) obtained gravid females from southern Biscayne Bay in January, March, and April. Ovigerous *S. americanus* have been collected in Cuba in May and September (personal communication, Dr. J. A. Baisre). Verrill (1922:22) mentioned several gravid *Scyllarides aequinoctialis* from Bermuda but did not include dates of capture. There appear to be no published records of ovigerous *Scyllarus faxoni* or *Scyllarides nodifer.*

Figure 15 contains spawning data for Scyllaridae from the Florida west coast and represents only those specimens in the reference collection of the Florida Department of Natural Resources (FSBC). The smallest gravid female of each species was determined and all smaller females were excluded from this portion of the analysis. Admittedly, there is a chance that a precocious female could create a slight data bias toward including smaller than normally mature females, but the comparatively large size of *Scyllarus depressus* and the compactness of occurrence of ovigerous *Scyllarides nodifer* seem to minimize bias for these species.

Scyllarus americanus evidently spawns in Florida waters throughout the year. Since both ovigerous females and stage I phyllosomes have been found to be most abundant in late winter and spring, it is concluded that peak spawning occurs during these months, with occasional spawning during the remainder of the year. *Scyllarus chacei* also seems to spawn throughout the year. Our data indicates that they spawn most frequently in the spring, although the peak may extend into July. Of the 15 gravid specimens at the U. S. National Museum from waters near Florida, ten were collected in March and the remainder were taken in January, February, May, and July. As Williams (1965) noted, the species spawns off the coast of South America in August, September and November (17 of 27 females were ovigerous in a collection made by the M/V *Oregon* between Suriname and Guyana on August 31, 1958). It is possible that peak spawning occurs later in the year in these more southern latitudes.

Gravid *Scyllarus depressus* taken in the Hourglass program in January and November, when considered with USNM records and Williams' (1965) record of spawning off North Carolina in June, may indicate spawning throughout the year. However, more data is needed for verification.

Since no *S. faxoni* were collected in the Hourglass cruises, the only spawning data available is that from the U. S. National Museum.

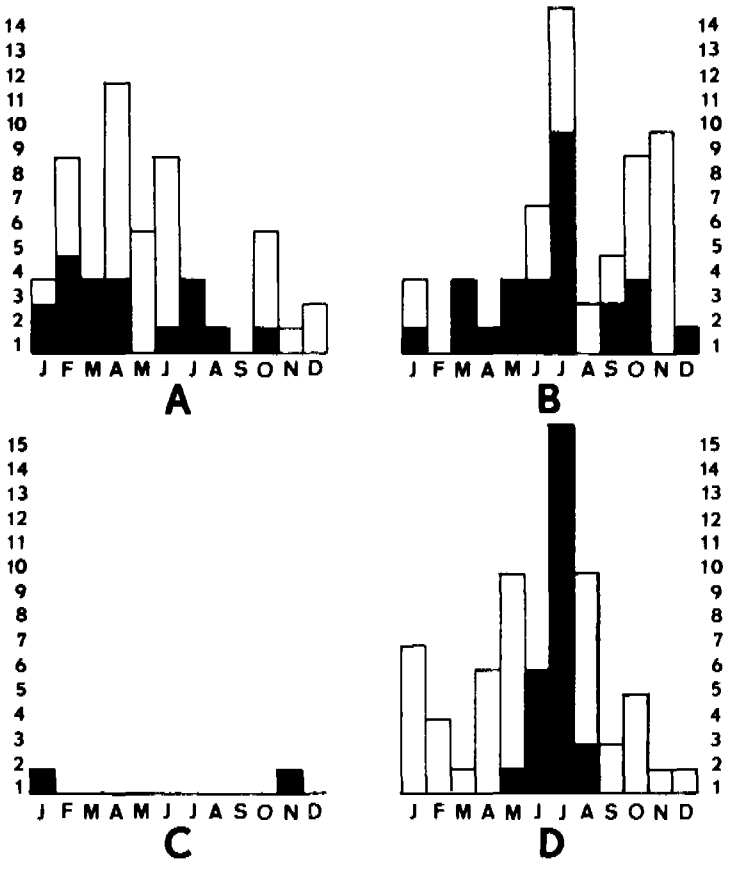


Figure 15. Ovigerous (■) and nonovigerous (□) female scyllarids from the eastern Gulf of Mexico, recorded by month: (A) *Scyllarus americanus*; (B) *S. chacei*; (C) *S. depressus*; (D) *Scyllarides nodifer*. Only females equal to or greater than the smallest ovigerous female are shown.

The best indication of seasonal spawning was found with *Scyllarides nodifer*. Fifty-nine mature females were taken in collections representing every month of the year. The 23 ovigerous lobsters were collected between the last half of May and the first half of August. All (20) adult females captured in June and July had eggs. Some *S. nodifer* appear to spawn at least twice in a single season. Females returned to the laboratory during the summer of 1967 were opened to determine condition of the gonads. Those specimens brought in during June and very early July had full, well-developed ovaries corresponding to stages 5 and 6 of Fielder (1964:134-136), even though eggs being carried on the abdomen were often "eyed" or otherwise in a late stage of development. Specimens collected later in July had smaller, spent gonads corresponding to Fielder's stage 7.

LARVAE

Recent papers by Sims (1964, 1965, 1966b, 1968), Sims and Brown (1967), Baisre (1966), and Robertson (1968a, b, c) have contributed immensely to our knowledge of the scyllaridean phyllosomes of the northwestern Atlantic. To avoid needless duplication of Dr. Robertson's investigations now in progress concerning development, morphology, and distribution of these larvae, this laboratory has postponed analysis of the scyllarid phyllosomes from Hourglass plankton collections until his work has been published. Papers dealing with some very large scyllarid phyllosomes and complete larval development of *Scyllarus americanus* (Smith) are already available and others concerning larvae of *S. chacei* Holthuis, *S. depressus* (Smith), *S. planorbis* Holthuis, *Scyllarides*

aequinoctialis (Lund), and *S. nodifer* (Stimpson) are in various stages of preparation (Robertson, personal communication). In his already published work, Robertson has shown that the period of larval life of *Scyllarus americanus* is only 32 to 40 days and confirms the statement of Baisre (1966) that the larvae are confined to coastal waters. According to Robertson, larval period in most other *Scyllarus* species is also rather brief, though possibly longer than that of *S. americanus*, which he feels may explain their absence from isolated islands such as Bermuda. He discusses (1968b: 334-335) previous estimates for ? *Parribacus* by Sims (1965) and *Ibacus* by Tokioka and Harada (1963) that larval life for these genera ranges from nine months to a year or more, concluding with the statement that "my studies indicate a prolonged larval period for *Scyllarides*." Robertson is apparently in agreement with Sims and Tokioka & Harada that the larval period of *Scyllarides* is about nine months to a year.

POSTLARVAE

The tendency of early workers to assign generic designations to the immediate postphyllosoma of palinurids and scyllarids has resulted in a confusing array of common names. Calman (1909) recognized that many species previously assigned to *Puerulus* Ortmann 1897 were in reality transparent postphyllosoma of other palinurids, and used "postlarva" to differentiate this stage. He was followed by Bouvier and others who also retained the term "puerulus" to refer to this form. Guerin-Meneville (1855) erected *Pseudibacus* to contain his *P. veranyi*, a wide, flattened transparent scyllaridean from the Mediterranean. Pfeffer (1881) named *P. gerstaeckeri* from the Atlantic Ocean and was followed by Miers (1882) with *P. pfefferi* from Mauritius. Sarato (1885) erected *Nisto* to contain *N. asper* and *N. laevis*, both Mediterranean. Other workers suspected that their specimens of these forms were immature and placed them in known genera but assigned them specific designations (e. g., Smith, 1881: *Arctus depressus*; Bate, 1888: *Arctus immaturus*; Bouvier, 1905: *Arctus crenulatus*; Rathbun, 1906: *Parribacus papyraceus*). Bouvier (1913) showed that *Pseudibacus* Guerin-Meneville and *Nisto* Sarato were actually postphyllosomic stages of *Scyllarides* and *Scyllarus*. Boas (1880) first used "natant stage" for these forms, including in his study palinurids and the scyllaridean genera *Scyllarus* (of Dana, 1852 [not Fabricius, 1775] = *Scyllarides* Gill, 1898) and *Parribacus* Dana. This usage was followed by Bouvier (1913, 1915a, c, 1917, 1925, 1940) who used the term interchangeably with "puerulus" when speaking of palinurids, with "nisto" of *Scyllarus* Fabricius, and with "pseudibacus" of *Scyllarides*. He also referred to these as postlarval stages (1915 a, b, c). He noted (1917, 1940) that Boas' postlarval specimen of *Parribacus* was similar to a "pseudibacus" but did not refer to it by that term. In 1925 (p. 444) he stated that "le nom de Pseudibacus . . . s'applique aux formes natantes des Scyllarides et sans doute aussi des autres Scyllarides primitifs (Scyllarides a test large et aplati: Thenus, Parribacus, etc.)." To my knowledge, only postlarvae assignable to *Scyllarides* s.s. have ever been actually described under the name *Pseudibacus*.

There is an evident need for standardization of terms used to designate transparent postphyllosoma in the Scyllaridae. "Postlarva" and "natant stage" have both served this purpose. I have found no reference to "natant stage" which does not clearly refer to the first postphyllosomic stage. This is unfortunately not true of the term "postlarva." Lewis *et al.* (1952), Witham *et al.* (1964) and others have used "postlarva" to refer not only to this stage but to as many as ten successive stages, not defining the upper limit of the term.

"Postlarva" as used here refers only to the transparent stage which occurs immediately after metamorphosis from the last phyllosome. This term is preferred to "natant stage" and "reptant stage" as each of the latter apparently designates a mode of living which only partially describes that traversed by this unique stage.

The most obvious characters separating postlarvae from juveniles are lack of coloration until just prior to ecdysis, a generally smooth rather than spiny or granular exoskeleton, a depressed carapace, and proportionately large pleopods equipped with long natatory setae. These characters seem to be shared by postlarvae of all genera within the Scyllaridea and are distinctive enough to separate them from all subsequent stages.

Gurney (1942) questioned the appropriateness of "natant stage." He documented two specimens of *Panulirus argus* taken in plankton at night in Bermuda, but speculated that they may have been attached to *Sargassum* as they did not swim freely in the laboratory. Dotsu *et al.* (1966) referred to their postlarvae of *Ibacus ciliatus* and *I. novemdentatus* as "reptant larvae," a term which suggests a creeping or benthic form. Robertson (1968b: 325) summarized the observations of Fedele (1926) and Dawydoff (1929) in *Scyllarus* and noted that his specimens of *S. americanus*, like other species observed, appeared to be essentially bottom-dwelling forms. Conversely, Deshmukh (1966) introduced the term "last larva," objecting to "postlarva" because he felt that it was not appropriate for palinurids since it "is a definite planktonic larval stage and the term is somewhat confusing with the next 'post-puerulus' stage."

I do not agree with Deshmukh and others that this stage should be considered larval, nor that it should be considered strictly planktonic. No subsequent evidence has been presented to support Gurney's speculation that postlarvae are transported via *Sargassum* rather than by swimming. Robertson's observation that the postlarva of *Scyllarus* is essentially a benthic form is equally unacceptable. Review of many reports concerning this postphyllosomic transparent stage in both Palinuridae and Scyllaridae indicate that they begin the stage as pelagic forms and later adopt a benthic existence. Pueruli of *Panulirus argus* are not an uncommon constituent of the plankton in Florida waters. Specimens have been found in plankton collections taken by the Florida Department of Natural Resources in the Yucatan Straits, the Florida Keys, and at St. Lucie Inlet. Gurney (1942) mentioned pueruli of *Jasus* taken in plankton far out at sea and nine postlarvae of *Palinurus vulgaris* taken from the stomach of a pelagic fish. Schroeder (1965:34) documents the capture of a palinurid puerulus swimming near the surface under a gas lantern in the Virgin Islands. Stephensen (1923:74), reporting on four "natant stages" of *Scyllarus arctus* collected by the *Thor* in the Mediterranean and eastern Atlantic, stated that "all . . . were taken pelagically at 920- over 4,000 m depth, by day with 300 m. w., at night with 25, 65 and 300 m. w."

Holthuis and Loesch (1967) reported ten postlarvae, probably *Scyllarides astori* Holthuis, from the Galapagos Islands. Nine were captured swimming at the surface under electric lights, the other being obtained from the stomach of a yellowfin tuna. Eleven postlarvae of *Scyllarides squamosus* (H. Milne-Edwards) from New Caledonia were likewise taken from stomachs of yellowfin tuna (Michel, 1968:48). Nakamura (1936) reported scyllarids from yellowfin tuna stomachs but did not specify whether they were postlarvae or other developmental stages.

Dr. Robertson kindly provided three *Scyllarides* postlarvae captured with night-light in Biscayne Bay, Florida. The U. S. National Museum collections contain one specimen of *Pseudibacus gerstaeckeri* Pfeffer (=*Scyllarides aequinoctialis* Lund) collected from a seawall in 0.6 meters of water in Biscayne Bay. Chace (1966) recorded one postlarva of *Scyllarides herklotsii* (Herklots) collected from a buoy at St. Helena Island and noted that the specimen was evidently about to metamorphose. Its capture conditions closely resemble those reported for *Panulirus argus* postlarvae by Lewis *et al.* (1952), Witham *et al.* (1964, 1968), and Sweat (1968) in that the specimens were collected from fouling organisms attached to relatively large objects suspended in the water.

Sheard (1949) noted that postphyllosomic "puerilla" were taken in surface currents and wind drifts, not becoming bottom-living organisms until after moulting "into a small, immature crayfish." He noted, as did others, that the smallest juveniles were found in the shallowest areas. Johnson

(1956) stated, "the puerulus of some species may be found in plankton, but evidently it soon deposits calcium in the carapace and seeks the bottom to live in concealment." Saisho (1966) was probably the first to point out that the pueruli occur offshore in oceanic water and return to coastal areas. He discussed the importance of their return, but not the mechanism.

Sweat (1968) was successful in obtaining large numbers of pueruli from inshore plankton in the Florida Keys but caught only a few palinurid phyllosomes, none of which were in later stages of development. He believed this indicated that they had metamorphosed in the deeper offshore waters where the late phyllosomes are usually taken in the plankton and had moved inshore. Orton and Ford (1933) proposed that pueruli of *Palinurus vulgaris* swim only at night, remaining on the bottom during the day. Data collected by Witham at the St. Lucie Inlet and by Sweat in the Florida Keys corroborate this proposal; although day and night plankton sampling was conducted, virtually all postlarvae were captured at night. Some evidently entered Witham Habitats (Witham *et al.*, 1968) in the Indian River estuary during the day, but this amounted to less than ten per cent of total habitat recruitment.

Postlarvae of *Scyllarus* collected by the Florida Department of Natural Resources in Hourglass and other programs also indicate swimming as well as benthic phases. Planktonic specimens were transparent, showing no trace of the color associated with impending ecdysis. Postlarvae taken in the dredge and bottom trawls generally displayed pigmentation. Adult and postlarval *Scyllarus* were collected from stomachs of scorpionfish (*Scorpaena brasiliensis*) and other benthic fishes, possibly implying that postlarvae were living in the benthos with the adults. These postlarvae always displayed some degree of pigmentation. Transparent postlarvae of *Scyllarus* and *Scyllarides*, as well as those of *Panulirus*, appear to be transitional stages linking planktonic phyllosomes with benthic juveniles and exhibiting characters of both.

Gurney (1942) mentioned the profound transformation of the phyllosoma to the postlarva in the Scyllaridea but pointed out that the "first postlarva" differs from the adult less than do "first postlarval" stages of many other decapod crustaceans. Although it is true that there is a strong resemblance of these stages to adults of their genera, much difficulty has been encountered in assigning postlarvae to their proper species (Prasad and Tampi, 1968:120), especially when more than one species occur in the same region. Often the identity of a postlarva has been determined merely by assigning it to the adult species most common in the area of collection.

Postlarvae of five species of Scyllaridae (two *Scyllarides*, three *Scyllarus*) have been examined from collections of the Florida Department of Natural Resources Marine Laboratory, the U. S. National Museum, and the Institute of Marine and Atmospheric Sciences, University of Miami. Four (*Scyllarides aequinoctialis, Scyllarus americanus, S. chacei,* and *S. depressus*) have been previously described; the fifth (*Scyllarides nodifer*) is herein presented for the first time (page 9).

Scyllarides nodifer (CL 9.3-10.7 mm; CW 9.5-11.6 mm; TL 21.0-26.0 mm). Setation counts for pleopod 1 are 5-6, 9-10, 14-15, 23-24, 20-21, and 14-16 for areas I through VI. Two juvenile *S. nodifer* (FSBC I 488, CL 10.7 mm and FSBC I 481, CL 10.8 mm) collected in 51 and 71 meters near Hourglass Stations L and M strongly resemble the postlarvae in size and general outline. Carapace width/carapace length ratios of the postlarvae varied from 1.02 to 1.15; small juveniles varied from 1.10 to 1.14. The same ratio for both *S. aequinoctialis* postlarvae was 1.23, greater than for the next larger juvenile *S. nodifer* (FSBC I 3134, CL 13.3 mm, CW 14.6 mm, CW/CL 1.10). The postlarvae believed to be *S. nodifer* were fitted to a size curve plotted for juveniles and adults of this species and showed a natural progression from postlarvae to juvenile animals. Conversely, postlarvae believed to be *S. aequinoctialis* did not show this progression, being larger in all respects than the smallest two *S. nodifer* juveniles (Figure 16).

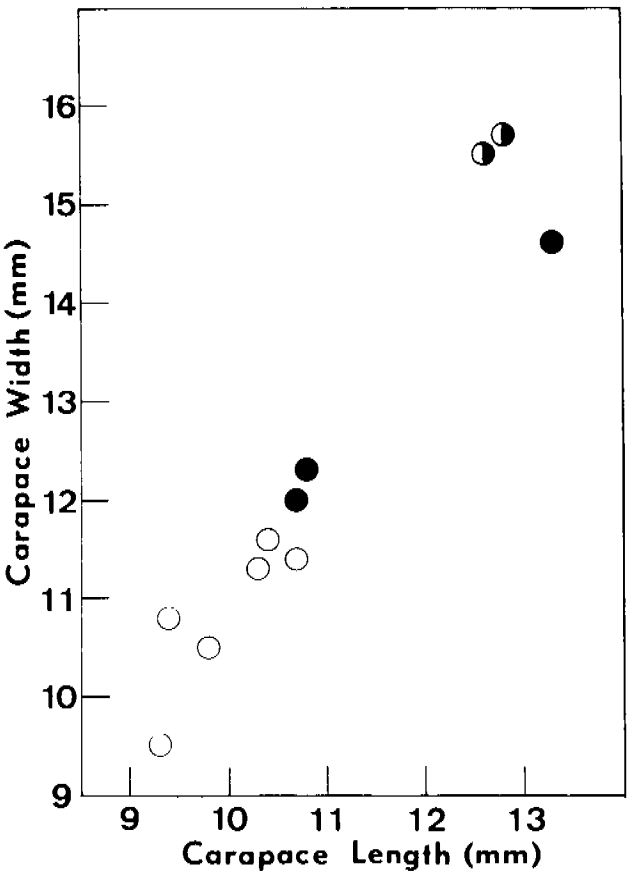


Figure 16. Relative morphometry of *Scyllarides nodifer* postlarvae (○) and juveniles (●), and postlarval *S. aequinoctialis* (◑).

Since spawning of *S. nodifer* was restricted, it is possible that the postlarvae will appear in a restricted period separated from the spawning season by a temporal span corresponding to the larval period of the species. Postlarvae were collected at Hourglass Stations L (55 m) and E (73 m), Biscayne Bay, and Vaca Cut Bridge near Marathon, Florida in late February, March, and early April, a minimum of 6.5 to a maximum of 10.5 months after the spawning season. When earliest spawning is compared with occurrence of earliest postlarvae and late spawning with latest appearing postlarvae, a span of eight to nine months is obtained for the larval period (Figure 17).

Scyllarides aequinoctialis (CL 12.6-12.8 mm; CW 15.5-15.7 mm; TL 26.1-29.3 mm). Setation counts for pleopod 1 are 5-6, 8-10, 11-13, 18-21, 19-20, and 13 for areas I through VI. Postlarvae identified as *S. aequinoctialis* are larger and possess a proportionately broader carapace than postlarvae of *S. nodifer*. Setation counts for pleopod 1 areas III, IV, and VI are lower than corresponding areas of *S. nodifer* but counts for areas I, II, and V overlap. Tips of the appendices internae of pleopods 2, 3, and 4 of one specimen (FSBC I 886) possessed a plumose seta not found on a similar specimen from Monserrat or on the six *S. nodifer* postlarvae. More such postlarvae should be examined to determine the extent of occurrence of this seta.

Pfeffer (1881) described this postlarva as *Pseudibacus gerstaeckeri* from the "Atlantischer Ocean." Bouvier (1913, 1917) first assigned it to *S. aequinoctialis* (Lund). Dr. L. B. Holthuis (personal communication) has informed me that Pfeffer's two syntypes at the Hamburg Museum are identical to a specimen collected at Biscayne Bay, Florida and housed in the collection of the U. S.

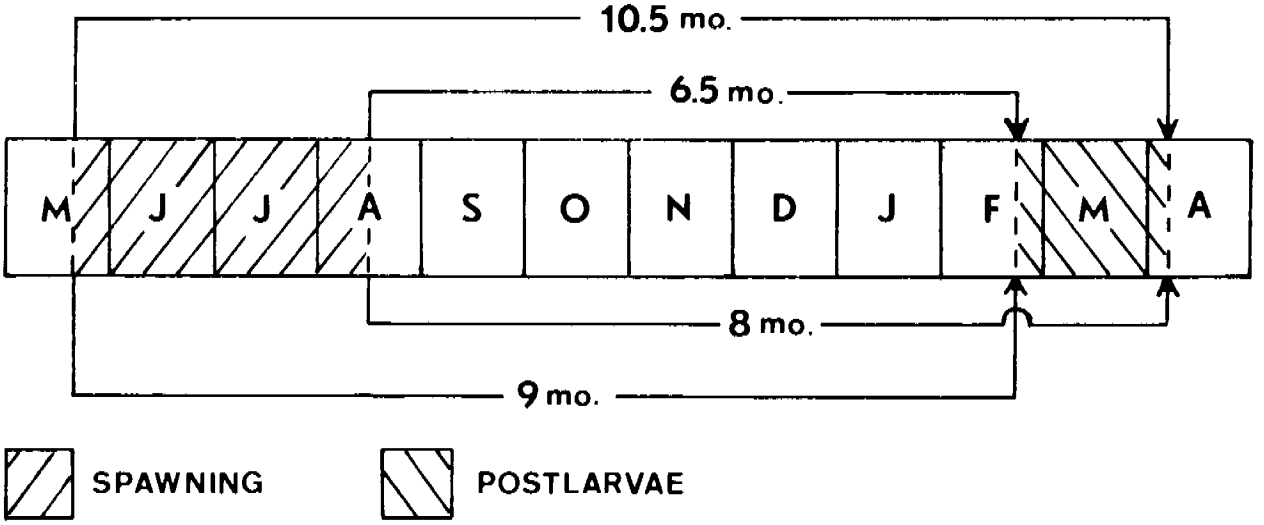


Figure 17. Times of spawning, and appearance of postlarvae in *Scyllarides nodifer*, from which probable length of larval life was computed.

National Museum (USNM 82988). This latter specimen was compared with one collected at Hourglass Station M and is identical. Early juveniles of *S. aequinoctialis* were not available for comparison. However, since *S. nodifer* is the only other *Scyllarides* species known from these waters and since its postlarva differs markedly from the present type, it is probable that this has been correctly assigned to *S. aequinoctialis.*

Postlarvae examined were collected at Monserrat, West Indies in March, Biscayne Bay in April, and Hourglass Station M in September. Robertson (1968a) mentions an additional specimen from Key Largo, Florida taken in January. A postlarva of *Scyllarus* Dana (=*Scyllarides* Gill) discussed by Boas (1880) and Bouvier (1917) was collected off the east coast of Brazil (07 °15'S X 32 °52'W), within the ranges of *Scyllarides brasiliensis* Rathbun, *S. deceptor* Holthuis and *S. delfosi* Holthuis (Rathbun, 1906; Ramos, 1951; Holthuis, 1960, 1963; Nomura and Filho, 1966; Filho, 1966), and probably belongs to one of these species rather than to *S. aequinoctialis.*

Scyllarus americanus (CL 2.8-3.0 mm; CW 3.3-3.9 mm; TL 7.5-8.1 mm). Pleopod 1 setation counts are 2, 4, 6, 9-10, 7-8, and 8-10 for areas I through VI. Robertson (1968b) described *S. americanus* postlarvae obtained by rearing through metamorphosis phyllosomes of known parentage in the laboratory. Earlier he mentioned postlarvae of *S. chacei* obtained by holding through metamorphosis late phyllosomes captured in plankton tows. These phyllosomes were identical to larval *S. chacei* hatched and reared in the laboratory but the postlarvae were not apparently distinguishable from those of *S. americanus* (Robertson, 1968a:102-106). Seventeen postlarvae examined in the present study generally agreed with his description.

Although Robertson did not list pleopod setae counts for *S. americanus*, his figure (1968b:323, fig. 14B) of the pleopod of the second abdominal segment (pleopod 1) shows 1, 4, 5, 9, 6, and 8 setae for areas I through VI. Table 1 shows setae counts for 16 of our 17 specimens. Only three of these have counts approximately the same as that of his illustration. Areas II, IV, and VI agree with his counts while areas I, III and V do not, my minimum count in each case being 1 seta higher. Too few specimens have been examined to attempt to define the extent of setae variation at this time.

TABLE 1. SETATION OF PLEOPOD 1, *SCYLLARUS* POSTLARVAE[1]

COLLECTION NUMBER (FSBC I)	CL	CW	TL	AREA OF PLEOPOD 1						MONTH OF CAPTURE	DEPTH (m)
				I	II	III	IV	V	VI		
6901	2.8	3.3	7.5	2	4	6	9	7	8	MAY	18
6901	3.0	3.8	8.0	2	4	6	10	7	9	MAY	18
6904	3.0	3.9	8.1	2	4	6	10	8	10	OCTOBER	18
6907	3.0	3.9	*	3	6	7	12	10	11	MAY	37
6517	3.2	4.0	8.5	2	7	6	11	9	9	JANUARY	73
6978	3.2	4.1	8.5	2	6	6	12	9	11	AUGUST	37
4295	3.2	4.0	*	*	*	*	*	*	*	SEPTEMBER	55
6899	3.3	4.0	8.6	2	6	7	12	9	10	JUNE	55
6900	3.3	3.9	8.3	3	6	7	12	9	10	OCTOBER	37
6909	3.8	4.0	9.2	3	6	6	12	9	10	JUNE	55
6911	3.9	4.2	10.0	3	8	7	13	9	10	JULY	37
6913	3.9	4.2	9.5	3	7	7	12	10	12	SEPTEMBER	55
6906	4.0	4.4	11.0	3	7	7	12	9	11	MAY	55
6908	4.0	4.6	10.0	3	7	7	12	9	11	MAY	55
6882	4.0	4.3	10.4	3	8	8	13	10	12	JULY	55
6883	4.0	4.6	10.7	2	6	7	11	9	10	JULY	55
6514	4.0	4.2	9.9	2	6	7	13	9	10	AUGUST	73

* = Damaged.

[1] FSBC I 6901 and 6904 are *Scyllarus americanus*; all others are *S. chacei*.

Robertson (1968b:330) noted the inshore distribution of adult *S. americanus* and reported phyllosomes of the species out to a maximum depth of only 48 m. Significantly, all three postlarvae herein assigned to *S. americanus* were captured at inshore (18 m) stations. One specimen was caught in a dredge haul at Hourglass Station B in November, two were captured in a plankton tow off Naples, Florida (26 °07'N X 82 °10'W, bottom depth 18 m, tow depth 9 m to surface) in May. All postlarvae from greater depths possessed pleopod setae counts which placed them in the group I have assigned to *S. chacei*.

Scyllarus chacei (CL 3.0-4.0 mm; CW 3.9-4.6 mm; TL 8.3-11.0 mm). Setae counts for pleopod 1 are 2-3, 6-8, 6-8, 11-13, 9-10, and 9-12 (Table 1). Fourteen postlarvae from our collections were assigned to this species on the basis of the difference discussed above. None of the setae counts agree with Robertson's illustration. My minimum counts in areas I, III, and VI are 1 seta higher while those at areas II, IV, and V differ more.

Specimens were collected from the following depths and stations: 37 m, Hourglass Station C, 2 postlarvae in dredge, 1 in bottom-to-surface step-oblique plankton tow; 55 m, Hourglass Station D, 5 in dredge, 1 in 20-ft. balloon trawl; Hourglass Station L, 1 in dredge, 1 in bottom-to-surface step-oblique plankton tow; 73 m, Hourglass Station E, 1 in 20-ft. otter trawl; Hourglass Station M, 1 in 45-ft. otter trawl. Three were captured in May, two in June, three in July, one in August, two in September, one in October, and one in January. Early juvenile *S. chacei* were also present in one

trawl and three dredge samples which contained these postlarvae. In addition, larger *S. chacei* were found in several of the samples.

Robertson (1968b:319) noted short, nonsetose vestiges of the larval exopods at the outer distal end of the basis of periopods 1-4 of his *S. americanus* postlarvae. In my study, postlarvae of *S. americanus, S. chacei,* and *S. depressus* were all found to vary with regard to these vestigial exopods. Both our *S. americanus* specimens from the plankton possessed these exopods although they were poorly developed. The dredged specimen had only rudimentary buds. Two of three *S. chacei* postlarvae from plankton collections had nonsetose exopods nearly half as long as their respective periopods while the other, like the 11 specimens from dredge and trawl collections, had only rudimentary buds. The single *S. depressus* from a plankton collection had exopods proportionately longer compared to their associated periopods than any found on *S. americanus* or *S. chacei*. Three USNM postlarvae of *S. depressus* collected in bottom trawls had only small buds.

Some question has existed as to the number of stages of transparent postphyllosoma within a species. Bouvier (1913) recognized *Nisto asper* and *N. laevis* as postlarvae of *Scyllarus*, deciding that they were both of the same species, *S. arctus*. He later stated (1915a, 1917) that the two were separate postlarval stages of *S. arctus, Nisto asper* being the first stage and *N. laevis* the second, and extended his theory of two postlarval stages to include *Arctus immaturus* Bate, 1888 which he believed to be the second postlarva of *Scyllarus pygmaeus* (Bate, 1888) (Bouvier, 1917:114-115). He also believed that *Arctus depressus* Smith 1881 was the second postlarval stage of *Scyllarus americanus* (Smith, 1869), and considered a specimen captured by the *Blake* in 146 meters off Sand Key, Florida, to be the first postlarval stage (Bouvier, 1925:450-452). Fedele (1925) maintained a final-stage phyllosome (supposedly *S. arctus*) through metamorphosis to the postlarva. This specimen differed from both *Nisto asper* and *N. laevis* but resembled the latter more closely. Bouvier (1940) accordingly reversed his sequence of 1917 and decided that scyllarids "comme les langoustes" (1940:91), go through several postlarval stages. For *S. arctus* he defined the first as that of Fedele, the second as *N. laevis*, and the last as *N. asper*. Gurney (1942:236) evidently overlooked this last paper, but accepted Bouvier's theory of two separate postlarval stages. No mention is made in the literature concerning the further development of postlarvae held *in vivo* by Fedele (1925). Robertson (1968b) was unable to maintain his specimens beyond the first postphyllosoma. Alikunhi (1949) in an abstract of his presentation to the 35th Indian Science Congress discussed larval and postlarval stages of two species of *Scyllarus* and a single species of *Panulirus*. He stated that "the postlarval specimens thrive in aquaria and grow by regular moults" (p. 193). Unfortunately, the results of his work have not been published and the question of multiple postlarval stages remains unresolved.

The wide variation in size and in degree of exopod atrophication of our *S. chacei* and other postlarvae might suggest that more than one stage is present in the collections. There appears to be a correlation of exopod development with position of the postlarva in the water column. Exopods of planktonic postlarvae were generally more prominent than those of benthic animals.

However, Robertson (1968b) found that development of later stage phyllosomes of *S. americanus* in the laboratory was variable, with some specimens metamorphosing to postlarvae from stage VI while others became stage VII phyllosomes before metamorphosis. Total length of his final phyllosomes (stages VI and VII) varied from 9.7 to 13.3 mm (Robertson, 1968:321, Table 5). Number of pairs of swimming setae on the exopods of his final phyllosomes demonstrated about the same degree of variation as do the number of setae on pleopods of my postlarvae. As no other Reptantia are known to have more than one stage corresponding to the postlarvae of the Scyllaridea, it appears most likely that the variation believed by Bouvier to signify multiple postlarval stages is, in reality, simply a normal progression from variable final phyllosomes.

Hopefully this perplexing problem will be resolved when we are able to maintain and observe specimens of *Scyllarus* from phyllosoma stages through the entire transition to juvenile lobsters. Recent advances in rearing techniques indicate that the answer should soon be forthcoming (Provenzano, 1969).

Scyllarus depressus (CL 5.7-5.9 mm; CW 6.6-6.9 mm; TL 15.3-17.1 mm). Setation counts for pleopod 1 are 6-7, 11-12, 13-14, 21-23, 16-17, and 21-22 for areas I through VI. Specimens were captured in April, June, July, and September.

One postlarva (FSBC I 6932) was taken in an oblique plankton tow (46 m to surface) southwest of Dry Tortugas, Florida. Bottom depth at this station was approximately 2400 m. All other specimens examined were contained in the collections of the U. S. National Museum and were captured with dredge or trawl at depths ranging from 58 to 263 m, the deepest being somewhat greater than the maximum 183 m recorded for adults.

JUVENILES

A dramatic reduction in relative size of the pleopods at the moult from the postlarva to the first juvenile stage was noted in *Scyllarides nodifer, Scyllarus americanus, S. chacei*, and *S. depressus*. Pleopods remain reduced in juveniles until after development of genital pores, then rapidly increase in size in successive moults, being fully developed by the time the lobsters reach maturity. This suggests little use of these appendages during juvenile stages. Pleopods are evidently not necessary for swimming, since one juvenile *Scyllarus americanus* (FSBC I 6600) captured with dipnet and night-light was swimming at the surface (bottom depth 12.2 m) offshore from Egmont Key, Florida in July 1968. Mr. Michael Wollam, who captured the lobster, stated that it was swimming smoothly in a forward direction, not backwards in spurts by use of the entire abdomen as I have observed in alarmed individuals in aquaria. Pleopods of this specimen were of the same approximate size as those found on postlarvae of the species, but carapace length (7.9 mm) was more than twice that of the postlarvae and weight (0.35 g) was almost ten times greater.

Juveniles of all three *Scyllarus* species were otherwise like adults in relative proportionality. External morphology, including shape of incisions on abdominal terga, was also as in adults. Young *Scyllarides nodifer*, however, varied considerably from adults.

All previous accounts of *S. nodifer* describe the carapace as longer than wide, a condition not true for juvenile specimens. There exists a "crossover" size, between 30 and 40 mm, where carapace length and width are approximately equal (Figure 18). The female cited by Stimpson (1871:123) (CL 1.225 inches [31.12mm], CW 1.13 inches [28.70 mm]) is smaller than any I examined which possessed carapace length greater than width, but Stimpson may have used other points of reference to determine carapace length.

Granulation on the exoskeleton of small (pre-crossover) juveniles is as in adults, although less apparent. A few prominent granules are found on the gastric, cardiac, and branchial regions (Figure 19).

Certain characters evident in adults are more strongly accentuated in small juveniles. Gastric and cardiac prominences, for example, are strikingly evident, as are the branchial ridges parallel to the cardiac region. Median carinae of second and third abdominal segments are as in adults, but the fourth segment bears a high and well-developed node which is much more obvious than that of the corresponding adult segment.

Stimpson (1871:123) incorrectly stated that the node was on the third segment. He mentioned this feature in the original and subsequent descriptions but Verrill (1922) and Williams (1965) did not, probably because their descriptions were based on adults. The largest specimen cited by

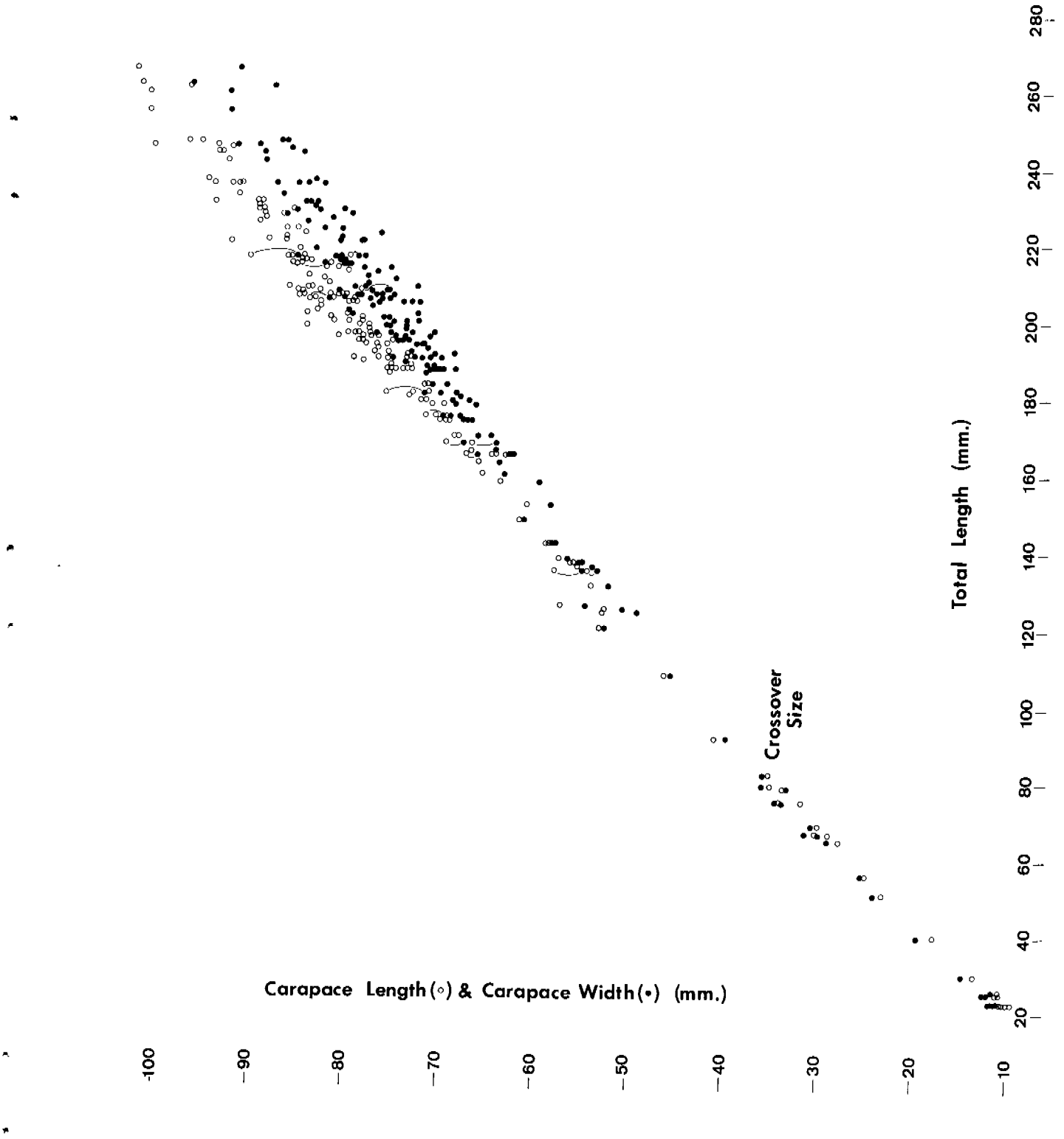


Figure 18. Carapace length and carapace width plotted against total length demonstrating changes of relative carapace morphometry in *Scyllarides nodifer*.

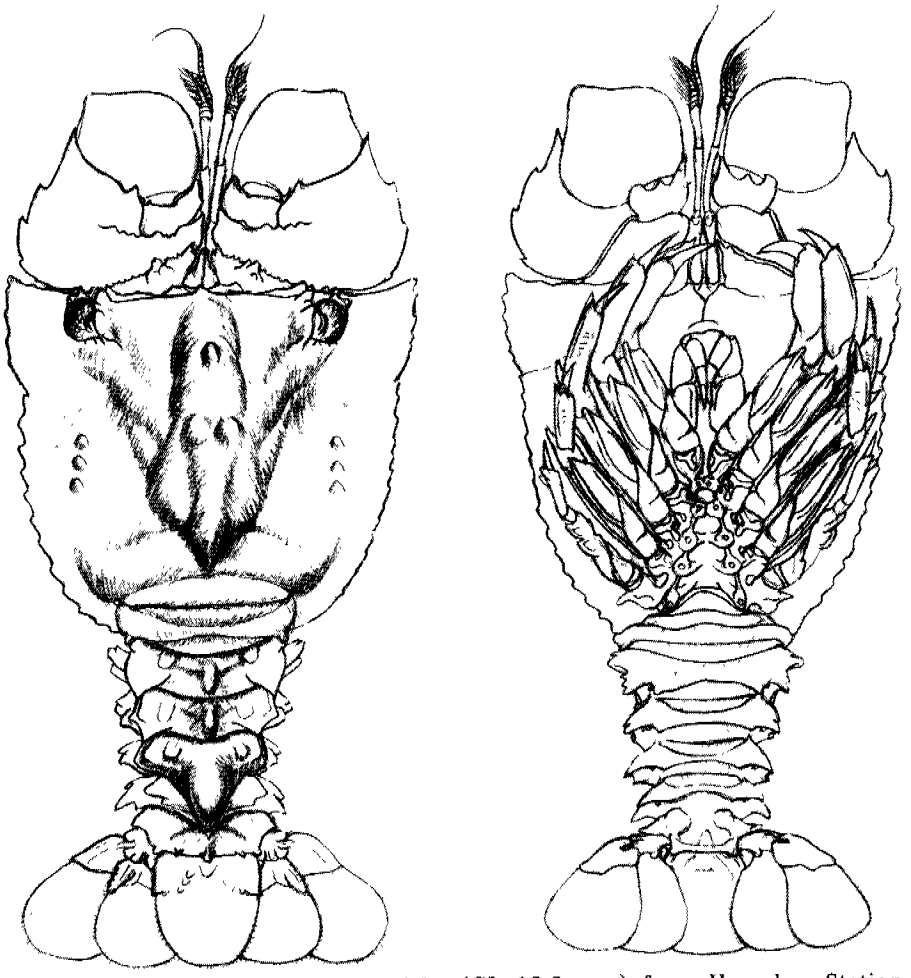


Figure 19. Juvenile *Scyllarides nodifer* (CL=13.3 mm) from Hourglass Station D (FSBC I 3134).

Stimpson measured about five inches (127 mm) total length. On specimens this size and smaller, the node would have been a more striking feature.

Rathbun (1935) erected the genus *Scyllarella* to contain two species (*S. gibbera* and *S. aspera*) from the lower Eocene of Alabama. Diagnosis for the genus is "carapace broader than long, cardiac region strikingly prominent, cervical and branchio-cardiac grooves deep; a lateral carina extends from the inner angle of the orbit to the posterior margin." All of these characters are descriptive of small *Scyllarides nodifer*. The illustration of *Scyllarella aspera* (Rathbun, 1935; pl. 21, fig. 18) was extremely difficult to interpret. However, those of *S. gibbera* (pl. 24, figs. 35-40) are quite clear and comparisons were made with *Scyllarides nodifer* of approximately the same size. The cardiac region of *Scyllarella gibbera* is more elevated than is the gastric region, whereas the regions are of approximately equal elevation in *Scyllarides nodifer*. Four pairs of large tubercles extending from the summit of the cardiac prominence to near the posterior edge of the carapace in *Scyllarella gibbera* are lacking in *Scyllarides nodifer*, although numerous granules arranged in somewhat the same manner are present. The cervical groove is much deeper and wider where it crosses the lateral carina of *Scyllarides nodifer*, the carina extending closer to the orbit in *Scyllarella gibbera*. The lateral carinae are straight on *S. gibbera* but quite sinuose on *Scyllarides nodifer*, curving outward at an angle toward the lateral margins near the summit of the cardiac region and sharply inward near the branchio-cardiac groove. The nine or more low, widely spaced blunt teeth trending forward along the lateral margins of the carapace of *Scyllarella gibbera* are much more strongly developed than the numerous extremely small teeth of *Scyllarides nodifer*, but suggest the lateral teeth of *S. aequinoctialis* postlarvae.

Many similarities exist, however, between *Scyllarella* and juvenile *Scyllarides nodifer*, suggesting a close relationship, but because of the scarcity of juveniles of other *Scyllarides* species, no other comparisons were made.

ADULTS

The only species taken in sufficient numbers to allow construction of size curves were *Scyllarides nodifer* (Figure 20) and *Scyllarus chacei* (Figure 21). In both, females grew to a larger size and tended to be heavier than males of the same length. Females were also larger than males in the few *Scyllarus americanus* and *S. depressus* taken.

Table 2 lists maximum adult carapace lengths of *Scyllarides nodifer, Scyllarus americanus, S. chacei,* and *S. depressus* found in the Hourglass program. Also listed are maximum carapace lengths for the same species reported by Williams (1965). The largest *S. nodifer* taken in our program was 24 mm shorter than the maximum reported by Williams. *S. chacei* and *S. depressus* females were found which were larger than previous reports. Although *S. americanus* from Hourglass stations were notably smaller than the maximum reported by Williams, over half our females were gravid, indicating an adult population. *S. americanus* captured in shallower water by bait shrimpers off the central west Florida coast and in Biscayne Bay regularly exceed our 18.7 mm maximum carapace length, reaching 25.3 mm off west Florida and 25.9 in Biscayne Bay (Lyons, unpublished data). The small average size of adults in the Hourglass samples is enigmatic.

DISTRIBUTION

Scyllarides nodifer. These lobsters occur throughout the Gulf of Mexico and are common along the west Florida shelf. They have also been reported from Cuba (von Martens, 1872; as *S. latus*), the Florida Keys (Stimpson, 1866, 1871), North Carolina (Williams, 1965) and Bermuda (Verrill, 1922). No records of this species were found from south of Cuba or the Yucatan Straits. Dr. Julio A. Baisre has informed me that there are no Cuban records of *S. nodifer* at the Instituto de Oceanologia, Habana. Correspondence with staff members of the United Nations Caribbean Fisheries Development Project, Barbados, the Department of Marine Sciences of the University of Puerto Rico, the Department of Agriculture of Puerto Rico, and the Caribbean Research Institute of the College of the Virgin Islands produced records of *S. aequinoctialis* but none of *S. nodifer*. It appears that *S. nodifer* occurs only in the Gulf of Mexico and northward in the region where the larvae may be dispersed by the Gulf Stream. Von Martens' reference is the only record of *S. nodifer* from south of the Florida Current. His specimen was obtained from Dr. Johann Gundlach, and was referred to "der Sammlung von Gundlach Nr. 67" (Von Martens, 1872:122). Dr. L. B. Holthuis (personal communication) commented on this sample as follows: "In the old times it was not usual to make collecting stations and I guess that the 'Nr. 67' stands only for a number given to the specimen and does not stand for a locality. As Gundlach not only collected himself but also obtained material from others (e. g., from Poey) his specimens may have come from anywhere in Cuba, though it is of course most likely from the Havana area." Von Martens distinguished *S. latus* (which he thought his specimen to be) from *S. aequinoctialis*, which he also reported from Cuba. *S. latus*, which resembles *S. nodifer*, is not found in the western Atlantic.

The only other species known from the tropical western Atlantic resembling *S. latus* is *S. delfosi*, whose known distribution is restricted to the northern coast of South America (Holthuis, 1960). It is therefore probable that von Martens did have *S. nodifer*, but the absence of further records indicates that this species occurs only rarely in Cuba. The species is apparently excluded from the Caribbean Sea, the Florida Current acting as a barrier to recruitment from the Gulf of Mexico and the Florida Keys.

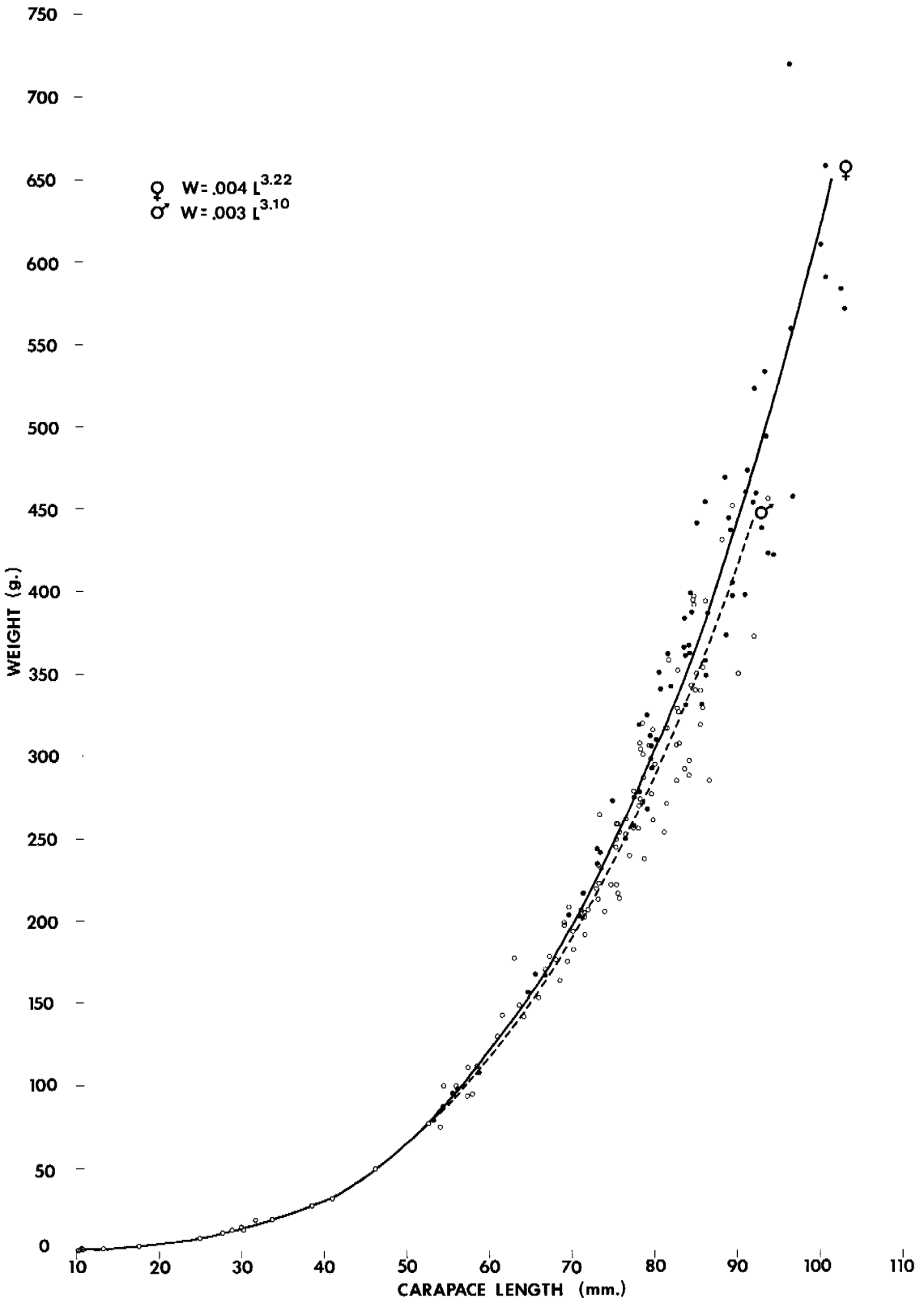


Figure 20. Carapace length vs. weight relationship of *Scyllarides nodifer*.

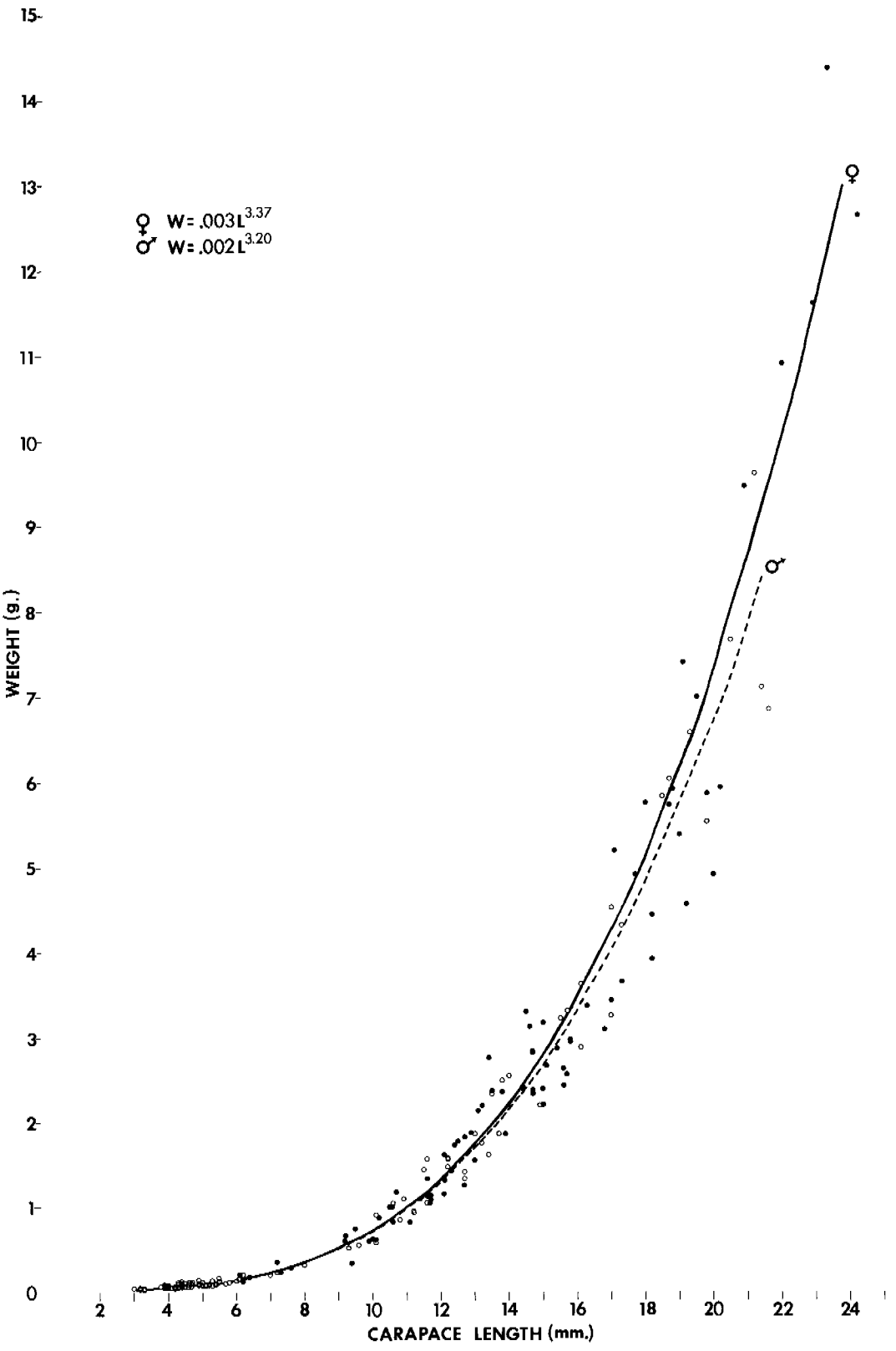


Figure 21. Carapace length vs. weight relationship of *Scyllarus chacei*.

TABLE 2. MAXIMUM CARAPACE LENGTHS OF HOURGLASS SCYLLARIDS AND PREVIOUS MAXIMUM SIZES REPORTED BY WILLIAMS 1965

	HOURGLASS		WILLIAMS 1965
	♂	♀	♀
Scyllarides nodifer	93.8	103.1	127.0
Scyllarus americanus	17.1	18.7	25.0
Scyllarus chacei	21.6	24.2	19.0
Scyllarus depressus	23.8	25.8	24.0

Robertson (1968a) has described phyllosomes of *Scyllarides aequinoctialis* hatched and raised from a known parent and discussed a series of identical larvae from plankton collections taken in the Caribbean Sea, Florida Straits, and northwestern Atlantic. He also discussed a similar series from plankton collection which he assigned to *S. nodifer*. It appears significant that all specimens of the latter series were captured in the Gulf of Mexico, in the northern edge of the Florida Current along the Florida Keys, and further north in the Gulf Stream.

S. nodifer has been captured in depths ranging from 2 to 91 m. Greatest concentrations were found in 30 to 42 m depths in the Hourglass study although specimens were occasionally taken at 18 m stations and rarely at 73 m (Table 3). Bottom composition at deeper stations was primarily sponge, coralline algae, and shell, but prominent limestone outcroppings and their accompanying flora and fauna characterized Station B (18 m).

Comparison of catch results obtained from regular and post-sampling produced 3.5 times more lobsters from southern stations than from northern. Although water temperatures were slightly higher at southern stations (Figures 22a, b) it does not seem that this small difference would account for such a disparity of distribution. Lobsters living on the comparatively rougher bottom encountered at Station B (and often at C) may have been less vulnerable to capture by trawl or dredge, a consideration strengthened by successful trapping results at or near the northern stations.

Deepest record for the species was obtained west of Ft. Myers, Florida in 91 m by the R/V *Hernan Cortez* (USNM 128027). The species is often encountered in much shallower depths in the Florida Keys than in the Gulf of Mexico, probably reflecting availability of suitable habitat.

Scyllarides aequinoctialis. Little can be added to existing information concerning distribution of this species. It has been previously reported from throughout the West Indies, south Florida, and Bermuda. A photograph at the U. S. National Museum shows a specimen captured about 25 miles off the coast of South Carolina. Hildebrand (1954) listed a specimen off the Texas coast from 31 m and cited two others landed from a fishing boat at Freeport, Texas. However, the only *Scyllarides* I have examined from Texas have been *S. nodifer*, a species not listed by Hildebrand. The single *S. aequinoctialis* from the Hourglass study was a postlarva from Station M. Verrill (1922) cited specimens from 9 to 183 m at Dominica. I encountered the species regularly in 3 to 15 m depths at Grand Cayman Island in the summer of 1965.

Scyllarus americanus. Before Holthuis differentiated *Scyllarus chacei* from *S. americanus*, Rathbun (1901) and Schmitt (1935) listed *S. americanus* from Puerto Rico. Re-examination of specimens at the U. S. National Museum revealed all Puerto Rican material in this species complex to be *S. chacei*, prompting Williams (1965) to designate southern Florida and the Campeche Banks off Mexico as the southern range limits of *S. americanus*. Shortly thereafter Baisre (1966) established the occurrence of *S. americanus* in Cuba. I have examined two *S. americanus* from the western side of Puerto Rico and one from the Gulf of Venezuela. One of the Puerto Rican specimens (USNM 127991) was in a collection also containing one *S. chacei*, the first record of

TABLE 3. MONTHLY CATCHES OF *SCYLLARIDES NODIFER* AT HOURGLASS STATIONS

	A	S	O	N	D	J	F	M	A	M	J	J	S*	A	S	O	N	D	J	W**	F	M	A	M	J	J	A	S	O	N	TOTAL
A																															
B					1	1	2																					1			5
C					1	1	2									1							1						1		7
D							1		1		2					1								1							6
E									1																						1
I																															
J								2	1	3			1			2	1													1	11
K						1	1			4		5	10			1	1				1	1		1			1				27
L			1	1	4	1	1	2		1	2	2	2	1	1		2		2	2	1			1	1			2		1	31
M											1																				1
																															89

* July 1966 Summer Supplement Cruise, 45 ft. Otter Trawl.

** January 1967 Winter Supplement Cruise, 45 ft. Otter Trawl.

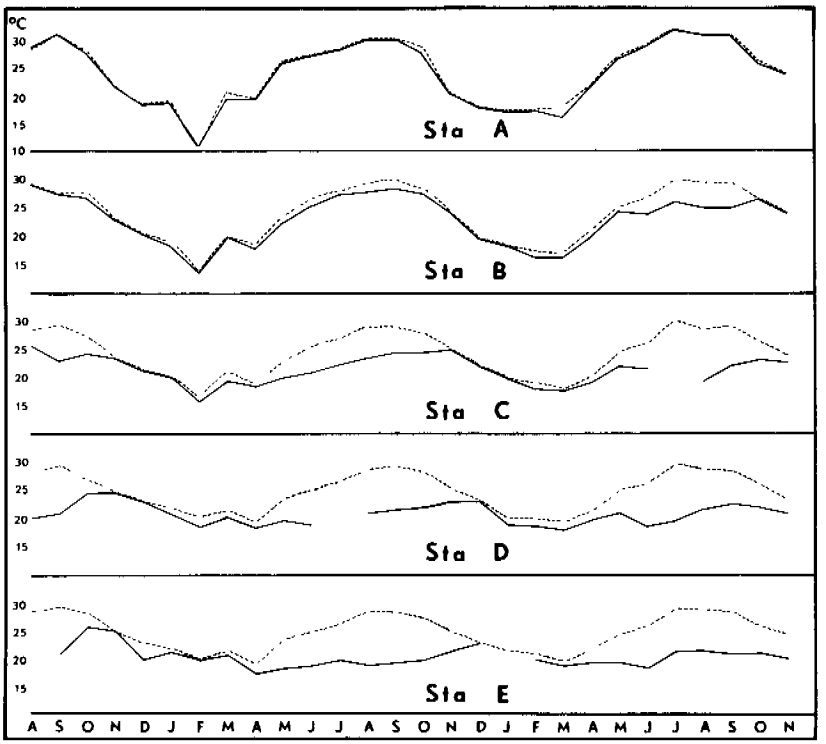


Figure 22A. Variation of monthly surface (- - -) and bottom (—) temperatures at Hourglass Stations A-E.

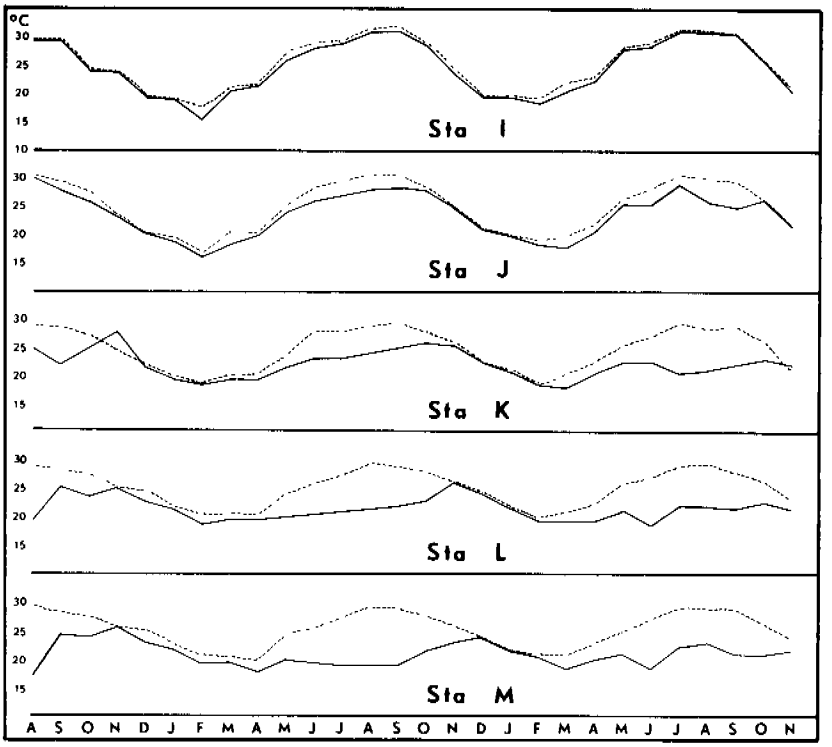


Figure 22B. Variation of monthly surface (---) and bottom (-) temperatures at Hourglass Stations I-M.

these species occurring together. Depth of capture of these specimens was 22.0-26.0 m, within previously reported depth ranges of both. I have examined one *S. americanus* taken two miles SSW of Alligator Light, Monroe County, Florida, depth 37 to 46 m, apparently the deepest record for the species. In Hourglass collections, 37 specimens were taken at 18 m, only one at 6 m (Station I) (Table 4). However, I have examined more than a thousand specimens captured in 2 to 6 meters by bait shrimpers off the central west coast of Florida and in Biscayne Bay.

Scyllarus chacei. This species is one of the most common and widely ranging of western Atlantic scyllarideans. *S. chacei* has been found from off Cape Lookout, North Carolina, through the Gulf of Mexico, the West Indies and the Caribbean coast of Central America to off Cape Sao Roque, Brazil. Large lots of these lobsters at the U. S. National Museum indicate that they are quite abundant off the northeast coast of South America. There are also many lots of this species from off northeast Florida, Georgia, and the Carolinas. *S. chacei* was the most common scyllarid encountered in the Hourglass program. Most specimens were taken at the 37 and 55 m stations but these lobsters were not uncommon at the 73 m stations (Table 5). No significant catch variation was noted between northern and southern stations.

The species has been previously reported elsewhere in depths ranging from 17 to 183 m (Williams, 1965). However, I have examined one specimen (FSBC I 6519) taken in 11 to 24 m off the Cay Sal Banks, western Bahamas, possibly a shallow range extension, and another (USNM 127995) from off northeast Florida in 320 m. The latter is the only specimen I have seen that has been captured in waters deeper than 183 m.

Holthuis (1969:157) pointed out that although *S. chacei* is found throughout the range of *S. planorbis*, the two species were never found together in the same catch, suggesting that they inhabit different ecological niches. Bottom composition where *S. planorbis* were taken was hard and consisted of shell rubble with some mud or sand. In the Hourglass program, *S. chacei* was taken on bottom composed primarily of sponge, dead and living coralline algae, and dead shell, with little sand but much silt.

Scyllarus depressus. Like *S. chacei, S. depressus* is widely distributed throughout the western Atlantic. The type specimen is a postlarva from off Martha's Vineyard, Massachusetts. Examination of subsequent collections indicates that this occurrence was probably adventitious, as no adults are known from north of North Carolina. I have seen one postlarva from off Cape Charles, Virginia. These postlarvae probably reflect northern transport of larvae along the western edge of the Gulf Stream similar to that reported by Sims (1968). As in many tropical fishes transported in this way, long term survival is doubtful. *S. depressus* has been taken as far south as Ilba de Sao Sebastiao, State of Sao Paulo, Brazil. One collection of 14 specimens (USNM 104511) made off Suriname indicates that *S. depressus*, like *S. chacei*, is well established off northeastern South America.

S. depressus was not common in Hourglass collections. Twelve of the 13 specimens captured were from 73 m stations, the other from a 55 m station (D) (Table 6). It is questionable that the 2:1 ratio of specimens from northern to southern stations is significant. Previously reported depth range was 55 to 183 m for this species (Williams, 1965). One specimen (USNM 128007) however, was taken in 29 m off the Carolinas. The only known specimen from deeper than 183 m is the postlarva from 263 m taken off Western Dry Rocks near Key West, Florida.

Station bottom types where *S. depressus* were captured in the Hourglass cruises were like those of *S. chacei* but, because Stations C and K were excluded, generally had fewer sponges, less sand, and more coralline algae and silt.

Scyllarus faxoni. Little is known about the distribution of this species. It has been taken infrequently throughout the tropical western Atlantic and Caribbean in depths ranging from 229 to 457 m. Scarcity of published reports and of museum material probably reflects the fact that the

TABLE 4. MONTHLY CATCHES OF *SCYLLARUS AMERICANUS* AT HOURGLASS STATIONS

	A	S	O	N	D	J	F	M	A	M	J	J	S*	A	S	O	N	D	J	W**	F	M	A	M	J	J	A	S	O	N	TOTAL
A																															
B			1	2		2	2	2		1	2				2	2	1			1	1	1			1	3			1	1	26
C																															
D																															
E																															
I							1																								1
J			1	1	2		1		1															1						4	11
K																															
L																															
M																															
																															38

* July 1966 Summer Supplement Cruise, 45 ft. Otter Trawl.

** January 1967 Winter Supplement Cruise, 45 ft. Otter Trawl.

TABLE 5. MONTHLY CATCHES OF *SCYLLARUS CHACEI* AT HOURGLASS STATIONS

	A	S	O	N	D	J	F	M	A	M	J	J	S*	A	S	O	N	D	J	W**	F	M	A	M	J	J	A	S	O	N	TOTAL
A																															
B																															
C				3		2				2			3	1	2	4		2	2	3				1	3	4	12	1	3	3	51
D	1							1				3		1		1			1	1	5			2	2	6	4	7	5	3	43
E											2		1	3		5											2		1	1	15
I																															
J																															
K				1					1		2	2	2		1			1		2		1			3			2	2	2	22
L			1									1	1	3	15			1			1			1	1			2	1		28
M						2									5					1		1	1					2			12
																															171

* July 1966 Summer Supplement Cruise, 45 ft. Otter Trawl.

** January 1967 Winter Supplement Cruise, 45 Ft. Otter Trawl.

TABLE 6. MONTHLY CATCHES OF *SCYLLARUS DEPRESSUS* AT HOURGLASS STATIONS

	A	S	O	N	D	J	F	M	A	M	J	J	S*	A	S	O	N	D	J	W**	F	M	A	M	J	J	A	S	O	N	TOTAL
A																															
B																															
C																															
D																														1	1
E														2				1		1		1		2						1	8
I																															
J																															
K																															
L																															
M																			1	2				1							4
																															13

* July 1966 Summer Supplement Cruise, 45 ft. Otter Trawl.
** January 1967 Winter Supplement Cruise, 45 ft. Otter Trawl.

upper continental slopes where *S. faxoni* occurs have not been well sampled. Specimens at the USNM were collected by the M/V *Oregon*, M/V *Combat*, and M/V *Silver Bay*, vessels of the Bureau of Commercial Fisheries of the U. S. Fish and Wildlife Service, whose primary mission has been to locate exploitable concentrations of marketable seafood. Species without commercial importance or potential are seldom brought to shore during these investigations. Consequently, the absence of *S. faxoni* in catch reports does not necessarily preclude its occurrence. More careful collection on the upper continental slope will probably reveal populations of this species in the Gulf of Mexico.

COMMENSALS

Most *Scyllarides nodifer* had various barnacles, ectoprocts, hydroids, sponges, annelid worms, and bivalve mollusks attached to their exoskeletons, the exceptions being either young lobsters or adults that had apparently recently moulted. Barnacles, *Balanus calidus* Pilsbry, were often attached to the carapace and upper suface of the abdomen. Hydroids, ectoprocts, annelids (Serpulidae), and a single small sponge were also attached in this manner. Additional serpulid worms, ectoprocts, and all bivalves were attached to the underside of the lobsters.

Pododesmus rudis (Broderip) (Anomiidae) was the most common bivalve. The species was attached to the thoracic and/or the abdominal sternum of 11 lobsters. One had completely blocked the oviduct of a lobster, probably impairing spawning efficiency temporarily, but the impairment would have been corrected with the next moult. *Arcopsis conradiana* (Dall) (Arcidae) was found on two lobsters. *Chlamys benedicti* Verrill and Bush (Pectenidae), *Chama congregata* Conrad (Chamidae), and *Hiatella arctica* (Linnaeus) (Hiatellidae), were each found only once. All species except *P. rudis* were always attached to the underside of the abdomen. Glynn (1961) mentions that 1.5% of the red crabs, *Pleuroncodes planipes* (Galatheidae), cast ashore at Monterey, California, in a mass stranding, carried one to two *Chlamys latiaurata* (Pectenidae). Those illustrated by Glynn were attached to chelipeds of the crabs. He speculated that attachment of this sort would be a good means of dispersal for the bivalves, providing the exuvia were cast off in a favorable habitat.

Octolasmis hoeki Stebbing, a stalked barnacle, was often found on the oral appendages, the inner lining of the carapace near the gills, and on the gills of *Scyllarides nodifer*. Sixty-eight adult lobsters (approximately 50%) were infested to some degree by this barnacle. Newman (1960) described a species of *Octolasmis* from gills of *Panulirus interruptus* (Randall), but there appear to be no previous reports of the genus from *Scyllarides*. Verrill (1922) listed four species of *Octolasmis* from "a spider crab" and on oral appendages and gill cavities of various Palinuridae from the West Indies and Bermuda. He referred to the genus as parasitic, but the relationship is probably less severe, the barnacle feeding from water circulated by respiration of the host. Admittedly, additional weight and increased resistance to movement of infested appendages might be detrimental to respiration of the lobster, but at least temporary respite will be gained with moulting.

Only small serpulid worms were found on the exoskeletons of the *Scyllarides aequinoctialis* examined. These specimens, all captured from reef environments in the Florida Keys, the Dry Tortugas, and the Caribbean, carried markedly fewer fouling organisms than did most *S. nodifer*.

Like *Scyllarides aequinoctialis*, *Scyllarus* exoskeletons were generally clean. *Scyllarus americanus* were found with serpulid worms or balanoid barnacles, but much less frequently than *Scyllarides nodifer*. One *Scyllarus americanus* from the Anclote Keys had a holdfast of an alcyonarian near the center of the upper surface of the carapace. Serpulid worms were found on *S. chacei*. On one specimen, a large worm tube covered most of the left eye.

PREDATION

Verrill (1922) reported a *Scyllarides nodifer* collected by Silas Stearns off Pensacola, Florida in a fish stomach. This appears to be the only published record of predation upon a scyllaridean lobster from the Gulf of Mexico. There is an additional record at the U. S. National Museum of one *S. americanus* Verrill (=*S. nodifer*) "about 6 3/4 inches overall, coughed up by a grouper caught January, 1939, off Coral Patch, 70 miles SSE of Apalachicola and 70 miles west of Cedar Keys, Florida." The specimen was identified and returned to sender.

In my study, four additional records are established for *Scyllarides*; a badly decomposed *S. nodifer* in the stomach of a tiger shark, *Galeocerdo cuvieri* (Peron and LeSueur), and another from a red grouper, *Epinephelus morio* (Valenciennes), both at Hourglass Station N; in the reference collection of the Florida Department of Natural Resources Marine Laboratory there are specimens taken from a red grouper captured at 26° 07' N latitude, 49 m, and from a gag grouper, *Mycteroperca microlepis* (Goode and Bean) from west of Johns Pass, Pinellas County, in 49 m.

All three *Scyllarus* species captured in regular Hourglass sampling were also recovered from fish stomachs (Table 7). Forty-five *S. chacei* were recovered from the stomachs of 27 scorpionfish, *Scorpaena brasiliensis* Cuvier. Three other species, *Scorpaena agassizi* Goode and Bean, *S. calcarata* Goode and Bean, and *S. dispar* Longley and Hildebrand occurred in the same catches but no *Scyllarus chacei* were found in their stomachs, indicating either the probability of 1) habitat similarity for *Scyllarus chacei* and *Scorpaena brasiliensis* that is not shared by the other three scorpionfishes or 2) different feeding patterns for these three. *Scyllarus chacei* was also found three times in the dusky flounder, *Syacium papillosum* (Linnaeus), once in a cubbyu, *Equetus acuminatus* (Bloch and Schneider), and once in a clearnose skate, *Raja eglanteria* Bosc. *Scyllarus depressus*, which occurred less frequently than *S. chacei* but which shared the four deepest stations, was found only once, in *Syacium papillosum* at Station M.

Bathymetric separation of *Scyllarus americanus* from *S. chacei* and *S. depressus* is further emphasized by examination of fish stomach contents. The two *S. americanus* taken in fish stomachs were from a *Scorpaena brasiliensis* at Station J and from a snakefish, *Trachinocephalus myops* (Forster) at Station B. There is one record at the U. S. National Museum of a *Scyllarus americanus* "regurgitated in fine condition by a grouper" which was captured 15 miles west of Bradenton Beach, Florida, at a depth of 15 m. As the specimen was identified and returned to sender before *S. chacei* was separated from *S. americanus*, it is not possible to positively identify the species but present data indicates that it probably was *S. americanus*.

Randall (1967) discussed the feeding habits of 212 species of West Indian reef fishes. Nine had fed in part on scyllarid lobsters. Three zooplankton feeders, *Myripristis jacobus* Cuvier & Valenciennes (Holocentridae), *Priacanthus arenatus* Cuvier & Valenciennes (Priacanthidae), and *Ocyurus chrysurus* (Bloch) (Lutjanidae), and a barracuda, *Sphyraena barracuda* (Walbaum) (Sphyraenidae) had eaten just the late larval stage. Scyllarid lobsters, not otherwise identified, were noted to contribute small proportions by volume to the diets of *Lutjanus griseus* (Linnaeus) (Lutjanidae) (0.9%), *L. jocu* (Bloch & Schneider) (1.8%), and *Anisotremus surinamensis* (Bloch) (Pomadasyidae) (0.5%). One *Balistes vetula* Linnaeus (Balistidae) had leg fragments of *Scyllarides aequinoctialis* in its stomach. *Epinephelus itajara* (Lichtenstein) (Serranidae) was found to be the only severe predator of *S. aequinoctialis*. Randall states that "23.3 per cent of the stomach contents of nine of these groupers consisted of scyllarids (primarily, if not entirely, *Scyllarides aequinoctialis)*" (p. 838). Significantly, *Panulirus argus* made up another 45.6% by volume of the stomach contents of the nine *E. itajara* and *Panulirus guttatus* comprised 6.6% of the stomach contents of 56 *Lutjanus jocu*.

TABLE 7. *SCYLLARUS* FROM HOURGLASS FISH STOMACHS

Hourglass Station	Depth (m)	Date	Fish Species	Number and species of *Scyllarus*	
E	73	7-19-66	*Scorpaena brasiliensis*	2	*S. chacei*
E	73	7-19-66	" "	1	"
E	"	"	" "	1	"
K	37	7-22-66	*Syacium papillosum*	1	"
L	55	"	*Scorpaena brasiliensis*	2	"
L	"	"	" "	2	"
L	"	"	" "	2	"
L	"	"	" "	1	"
L	"	"	" "	1	"
L	"	"	" "	1	"
L	"	8-06-66	*Syacium papillosum*	1	"
L	"	"	*Scorpaena brasiliensis*	7	"
L	"	"	" "	3	"
L	"	"	" "	2	"
L	"	"	" "	1	"
L	"	"	" "	1	"
C	37	8-11-66	*Equetus acuminatus*	1	"
K	"	9-04-66	*Scorpaena brasilliensis*	1	"
L	55	10-13-66	" "	4	"
D	"	11-09-66	" "	1	"
L	"	11-13-66	" "	3	"
L	"	"	" "	2	"
L	"	"	" "	1	"
D	"	12-02-66	" "	1	"
K	37	12-06-66	" "	1	"
J	18	1-12-67	" "	1	*S. americanus*
B	"	1-25-67	*Trachinocephalus myops*	1	"
C	37	2-05-67	*Scorpaena brasiliensis*	1	*S. chacei*
D	55	2-06-67	" "	1	"
M	73	5-16-67	*Syacium papillosum*	1	*S. depressus*
L	55	6-07-67	*Scorpaena brasiliensis*	1	*S. chacei*
D	"	6-21-67	*Raja eglanteria*	1	"
D	"	9-01-67	*Scorpaena brasiliensis*	1	"
L	"	9-05-67	" "	1	"
L	"	10-12-67	*Syacium papillosum*	1	"

ECONOMIC POTENTIAL

Trapping for *Scyllarides nodifer* was conducted at depths ranging from 9 to 55 m. Wire fish traps, rectangular and angled wood slat traps, and plastic Igloo traps were used. The plastic traps proved to be of little value in this project and their use was discontinued. Although trapping effort was approximately equal among the three designs, rectangular wood traps produced almost half (47.8%) of the total catch, followed by angled wood traps (29.8%), and wire (22.4%) (Table 8). Eight species of fish and two species of gastropods were used successfully as baits (Table 9). The greater success of mullet, jack crevalle, and bonito as baits simply reflects their more frequent usage.

The trapping program was designed to sample a variety of depths during each season of the year but this was not always possible (Joyce and Williams, 1969). The high incidence of trapping effort between 37 and 40 m reflects trapping carried out at Stations F/N during regular Hourglass cruises. Attempts were always made to set the traps on rough bottom but the low relief of these areas often made this difficult. SCUBA observations indicated that fathometer readings were sometimes deceptive in determining bottom types. Consequently, it is possible that trapping results would have been much higher if traps had always been placed in these more favorable areas.

TABLE 8. TRAP EFFICIENCY FOR *SCYLLARIDES NODIFER* FROM HOURGLASS EXPLORATORY TRAPPING PROGRAM

Traps	Rectangular Wood		Angled Wood		Wire		Plastic Igloo		Total Traps	
	#	%	#	%	#	%	#	%	#	%
Effort: Trap nights	226	32.15	224	31.86	244	34.71	9	1.28	703	100
Traps fished successfully	21	9.3	14	6.25	9	3.7	0	0.0	44	6.26
Catch: *S. nodifer*	32	47.8	20	29.8	15	22.4	0	0.0	67	100
Catch/unit of effort	.142	48.6	.089	30.5	.061	20.9	.000	0.0	.095	100

Results (Table 10) do not indicate a general availability of *S. nodifer* on the inshore west Florida shelf, with an average catch per set (the efficiency coefficient of Butler and Pease, 1965) of only 0.095 lobsters for the 703 sets. Inasmuch as no lobsters were trapped in depths less than 30 m, and when only depths greater than this are considered, the coefficient increases to 0.117. Ninety-four per cent of the lobsters were captured at depths between 30 and 40 m, with a coefficient of 0.187 or approximately two lobsters for every ten traps set.

Only 44 of the 703 traps set for one overnight period caught *S. nodifer*. Total catch from these 44 traps was 67 lobsters, or 1.52 lobsters per successful trap (Table 8). Catches were definitely better in the six-month period between April and September than during the remainder of the year. When the catch at best depths is considered for only these months, it is apparent that 35% of the trapping effort produced 88% of the total lobster catch, with a catch coefficient of 0.243. Average weight of these lobsters was 334.3 g (0.74 lbs). When the 0.243 efficiency coefficient is considered, this shows a catch of 0.18 lbs. per trap per night.

TABLE 9. SUCCESSFUL BAITS USED FOR *SCYLLARIDES NODIFER* IN THE HOURGLASS EXPLORATORY TRAPPING PROGRAM

Bait	Success (# traps)
Mullet	15
Jack Crevalle	7
Grouper Heads	3
Snapper Heads	1
Vermillion Snapper	1
Cut Permit	1
Conch (*Pleuroploca gigantea*)	1
Whelk (*Busycon contrarium*)	1
Unknown	4
Bonito	8
Barracuda	2
Total	44

TABLE 10. CATCH PER TRAP EFFORT, CALCULATED BY DEPTH AND MONTH, FROM HOURGLASS EXPLORATORY TRAPPING PROGRAM FOR *SCYLLARIDES NODIFER*

MONTH	DEPTH† 30-40 (9.1-12.2)	40-50 (12.2-15.2)	50-60 (15.2-18.3)	60-70 (18.3-21.3)	70-80 (21.3-24.4)	80-90 (24.4-27.4)	90-100 (27.4-30.4)	100-110 (30.4-33.5)	110-120 (33.5-36.6)	120-130 (36.6-39.6)	130-140 (39.6-42.6)	140-150 (42.6-45.7)	150-160 (45.7-48.7)	160-170 (48.7-51.8)	170-180 (51.8-54.8)	TOTAL	CATCH/TRAP EFFORT
MARCH, 1966												0/24				0/24	.000
APRIL, 1966							0/12		1/6	1/12			0/12			2/42	.048
MAY, 1966									2/6	15/42						17/48	.354
JUNE, 1966									2/6	0/6					0/39	2/51	.039
JULY, 1966									1/7	3/14		0/13	0/26			4/60	.067
AUG., 1966				0/11			0/11	10/36	3/6	1/12						14/76	.184
SEPT., 1966									5/24	0/12						5/36	.139
OCT., 1966										1/12						1/12	.083
NOV., 1966										0/12		0/6	0/12			0/30	.000
DEC., 1966	0/12									0/12			0/18			0/42	.000
JAN., 1967	0/4							2/12	0/6	0/6						2/28	.071
*FEB., 1967																	
MARCH, 1967										0/12					0/12	0/24	.000
APRIL, 1967			0/12			0/12				4/18						4/42	.095
MAY, 1967					0/12								1/6			1/18	.056
JUNE, 1967		0/12								4/18			0/10			4/40	.100
JULY, 1967				0/11						7/12			1/23		2/6	10/52	.192
AUG., 1967			0/12							0/6			0/12			0/30	.000
SEPT., 1967														0/6		0/6	.000
OCT., 1967		0/8								0/12			0/4			0/24	.000
NOV., 1967										1/18						1/18	.056
TOTAL	0/16	0/20	0/24	0/22	0/12	0/12	0/23	12/48	14/61	37/236		0/43	2/123	0/6	2/57	67/703	
CATCH/ UNIT EFFORT	.000	.000	.000	.000	.000	.000	.000	.250	.230	.157	.000	.000	.016	.000	.035		.095

* Because of inclement weather, no trapping was conducted in February, 1967.

† Measured in feet, metric equivalents in parentheses.

Cope (1959) reported an average of three pounds of lobster per trap per week in the spiny lobster fishery of the Florida Keys. Robinson and Dimitriou (1963a) show figures ranging from 0.275 to 0.675 lbs. per trap per day in their study of the same fishery. The average for the six-month period appears to be approximately 0.5 lbs. per trap per day, about the same as that reported by Cope. Butler and Pease (1965) reported an average of approximately three pounds per trap per week under favorable conditions in their exploratory lobster fishing program along the Pacific coast of Panama.

Unless great care was exercised in trap placement the 0.18 lbs of lobster per trap per day could probably not be much improved in the area sampled. This figure is not sufficient to support a fishery, especially when higher cost of fishing at greater distances and depths is considered. However, in view of better trawling catches in more southerly areas, commercial potential of this species might yet be realized.

LITERATURE CITED

ALIKUNHI, K. H.

1949. Note on the metamorphosis of phyllosoma larvae from the Madras plankton. *Proc. 35th Ind. Sci. Congr., Abstracts, 35*(3): 193.

BAISRE, J. A.

1966. Desarrolle larval en *Scyllarus* sp. (Crustacea, Decapoda) con notas sobre la abundancia y distribucion de sus estadios. *Estudios Inst. Oceanol. Acad. Cien. Cuba, 1*(1): 5-34.

BARNARD, K. H.

1950. Descriptive catalogue of South African decapod Crustacea. *Ann. South African Mus. 38:* 1-837.

BATE, C. S.

1888. Report on the Crustacea macrura dredged by H. M. S. Challenger during the years 1873-1876. *Rep. Voy. Challenger (Zool.)*, 24: 1-924.

BOONE, L.

1925. Scientific results of the first oceanographic expedition of the "Pawnee." *Bull. Bingham Oceanog. Coll. 1*(2): 88.

BOONE, L.

1930. Crustacea: Anomura, Macrura, Schizopoda, Isopoda, Amphipoda, Mysidacea, Cirripedia, and Copepoda. Scientific results of the cruises of the yachts *Eagle* and *Ara*, 1921-1928, William K. Vanderbilt, commanding. *Bull. Vanderbilt Mar. Mus.*, 3: 1-221.

BOUVIER, E. L.

1905. Sur les Palinurides et les Eryonides recueillis dans l'Atlantique oriental par les expeditions francaises et monegasques. *C. R. Acad. Sci.*, 140: 479-482.

BOUVIER, E. L.

1913. Sur les genres *Pseudibacus* et *Nisto* et le stade natant des Crustaces Decapodes macroures de la famille des Scyllarides. *C. R. Acad. Sci. Paris*, 156: 1643-1648.

BOUVIER, E. L.

1914. Recherches sur le developpement post-embryonnaire de la langouste commune *(Palinurus vulgaris). J. Mar. Biol. Ass. U.K.*, n.s., x(2): 179-193.

BOUVIER, E. L.

1915a. Sur les formes adaptatives du *Scyllarus arctus* L. et le developpement post-larvaire des Scyllares. *C. R. Acad. Sci. Paris*, 160: 288-291.

BOUVIER, E. L.

1915b. *Scyllarus paradoxus* Miers. Structure, developpement post-larvaire, distribution geographique. *Bull. Mus. Hist. Nat., Paris*, 21: 47-50.

BOUVIER, E. L.

1915c Decapodes marcheurs (Reptantia) et Stomatopodes recueillis a l'Ile Maurice par M. Paul Carre. *Bull. Sci. Fr. Belg.*, 7 Ser., *48*(3): 11-19.

BOUVIER, E. L.

1917. Crustaces decapodes (macroures, marcheurs) provenant des campagnes *Hirondelle* et *Princess-Alice* (1885-1915). *Res. Camp. Sci. Monaco*, 50: 140 pp.

BOUVIER, E. L.

1925. Report on the results of dredging under the supervision of Alexander Agassiz, in the Gulf of Mexico (1877-78), and the Caribbean Sea (1878-79), and along the Atlantic Coast of the United States (1880) by the U. S. Coast Survey Steamer *Blake*. 48. Les Macroures, Marcheurs. *Mem. Mus. Comp . Zool.* (Harv.), *47*(5): 397-472.

BOUVIER, E. L.

1940. Decapodes marcheurs. *Faune Fr.*, 37: 85-91.

BULLIS, H. R., JR. and J. R. THOMPSON

1965. Collections by the exploratory fishing vessels *Oregon, Silver Bay, Combat,* and *Pelican* made during 1956-1960 in the southwestern North Atlantic. *U. S. Fish. Wildl. Serv.*, Spec. Sci. Rep. Fish. No. 510, Wash.: 1-130.

BUTLER, J. A. and N. L. PEASE

1965. Spiny lobster explorations in the Pacific and Caribbean waters of the Republic of Panama. *U. S. Fish Wildl. Serv.* Spec. Sci. Rep. Fish. No. 505, Wash.: 1-26.

CALMAN, W. T.

1909. The genus *Puerulus*, Ortmann, and the post-larval development of the spiny lobsters (Palinuridae). *Ann. Nat. Hist.* 8e Serie, *8*(1909): 441-446.

CHACE, F. A., JR.

1966. Decapod crustaceans from St. Helena Island, South Atlantic. *Proc. U. S. Nat. Mus.* 118: 622-662.

COPE, C. E.

1959. Spiny lobster gear and fishing methods. *U. S. Fish Wildl. Serv.*, Fish. Leafl. 487: 17 pp.

DAWYDOFF, C.

1929. A propos de la metamorphoses des crustaces loricates. *Arch. Zool. Exp. Gen.*, Notes et Rev., 67: 16-18.

DE MAN, J. G.

1922. The Decapoda of the Siboga Expedition: Pt. 5, Macrura. *Siboga Exped.*, mon. 39a4: 1-51.

DESHMUKH, S.

1966. The puerulus of the spiny lobster *Panulirus polyphagus* (Herbst) and its metamorphosis into the post-puerulus. *Crustaceana, 10*(2): 137-150.

DOTSU, Y., K. SENO, and S. INOUE

1966a. Rearing experiments on early phyllosomas of *Ibacus ciliatus* (von Siebold) and *I. novemdentatus* Gibbes (Crustacea: Reptantia). *Bull. Fac. Fish., Nagasaki Univ.*, 21: 181-194.

DOTSU, Y., K. SENO, and S. INOUE

1966b. Metamorphosis of the phyllosomas of *Ibacus ciliatus* (von Siebold) and *I. novemdentatus* Gibbes (Crustacea: Reptantia) to the reptant larvae. *Bull. Fac. Fish. Nagasaki Univ.*, 21: 195-221.

FEDELE, M.

1926. La metamorfosi dal phyllosoma dello *Scyllarus arctus. Boll. Soc. Nat. Napoli,* 37: 215-223.

FIELDER, D. R.

1964a. The spiny lobster, *Jasus lalandei* (H. Milne-Edwards), in South Australia. I. Growth of captive animals. *Aust. J. Mar. Freshw. Res.*, *15*(1): 77-92.

FIELDER, D. R.

1964b. The spiny lobster, *Jasus lalandei* (H. Milne-Edwards), in South Australia. II. Reproduction. *Aust. J. Mar. Freshw. Res.*, *15*(2): 133-144.

FIELDER, D. R.

1964c. The process of fertilization in the spiny lobster, *Jasus lalandei* (H. Milne-Edwards). *Trans. Roy. Soc. S. Aust.* (1964), 88: 161-166.

FILHO, J. F.

1966. Primeira contribuicao ao inventario dos crustaceos decapodos marinhos do nordeste Brasileiro. *Arq. Est. Biol. Mar. Univ. Fed. Ceara*, 6(1): 31-37.

GILL, T.

1898. The crustacean genus Scyllarides. *Science*, *7*(160): 98-99.

GLYNN, P. W.

1961. The first recorded mass stranding of pelagic red crabs, *Pleuroncodes planipes*, at Monterey Bay, California, since 1859, with notes on their biology. Calif. Fish Game, 47(1): 97-101.

GUILDING, L.

1825. An account of some rare West Indian Crustacea. *Trans. Linn. Soc. Lond. Zool.*, 14: 334-338.

GURNEY, R.

1942. Larvae of decapod crustacea. *Ray Society, London*, 129: 306 pp.

HARADA, E.

1958. Notes on the naupliosoma and newly hatched phyllosoma of *Ibacus ciliatus* (von Siebold). *Publ. Seto Mar. Lab.*, *7*(1): 173-179.

HARADA, E.

1962. On the genus *Scyllarus* (Crustacea Decapoda: Reptantia) from Japan. *Publ. Seto Mar. Biol. Lab.*, *X*(1): 109-130.

HAY, W. P. and C. A. SHORE

1918. The decapod crustaceans of Beaufort, N. C., and the surrounding region. *Bull U. S. Bur. Fish.* 35 (for 1915 and 1916): 369-475.

HILDEBRAND, H. H.

1954. A study of the fauna of the brown shrimp (*Penaeus aztecus* Ives) grounds in the western Gulf of Mexico. *Publ. Inst. Mar. Sci. Univ. Texas*, *3*(2): 233-366.

HOLTHUIS, L. B.

1946. The Decapoda Macrura of the Snellius Expedition. I. The Stenopodidae, Nephropsidae, Scyllaridae and Palinuridae. *Biol. Res. Snellius Exp.* 14. Temminckia, 7: 1-178.

HOLTHUIS, L. B.

1959. The Crustacea Decapoda of Suriname (Dutch Guiana). *Zool. Verh., Leiden*, 44: 1-296.

HOLTHUIS, L. B.

1960. Preliminary descriptions of one new genus, twelve new species and three new subspecies of scyllarid lobsters (Crustacea Decapoda Macrura). *Proc. Biol. Soc. Wash.*, 73: 147-154.

HOLTHUIS, L. B.

1963. Preliminary descriptions of some new species of Palinuridea (Crustacea Decapoda Macrura Reptantia). *Konink. Nederl. Akad. van Wetenschappen Amst.*, Proc. Ser. C, *66*(1): 54-60.

HOLTHUIS, L. B.

1969. A new species of shovel-nose lobster, *Scyllarus planorbis*, from the southwestern Caribbean and northern South America. *Bull. Mar. Sci., 19*(1): 149-158.

HOLTHUIS, L. B. and H. LOESCH

1967. The lobsters of the Galapagos Islands (Decapoda, Palinuridea). *Crustaceana, 12*(2): 214-222.

HOLTHUIS, L. B. and J. S. ZANEVELD

1958. De Kreeften van de Nederlandse Antillen. *Zool. Bijdragen*, 3: 1-26.

INGLE, R. M., B. ELDRED, H. W. SIMS, and E. A. ELDRED

1963. On the possible Caribbean origin of Florida's spiny lobster populations. *Fla. Bd. Conserv. Mar. Lab.*, Tech. Ser. No. 40: 1-12.

INGLE, R. M. and R. WITHAM

1968. Biological considerations in spiny lobster culture. *Proc. Gulf Carib. Fish. Inst.*, 21st Ann. Sess. Nov. 1968: 158-162.

JOHNSON, M. W.

1956. The larval development of the California spiny lobster, *Panulirus interruptus* (Randall), with notes on *Panulirus gracilis* Streets. *Proc. Calif. Acad. Sci., 29*(1): 1-19.

JOYCE, E. A., JR. and J. WILLIAMS

1969. Rationale and pertinent data. Memoirs of the Hourglass Cruises, Vol. I, Part I. *Fla. Dept. Nat. Resources Mar. Res. Lab.*: 1-50.

LEWIS, J. B., H. B. MOORE, and W. BABIS

1952. Post-larval stages of the spiny lobster *Panulirus argus. Bull. Mar. Sci. Gulf & Carib., 2*(1): 324-337.

MARTENS, E. VON

1872. Ueber Cubanische Crustacean. *Arch. Naturgesch., 28*(1): 77-147.

MICHEL, A.

1968. Les larves phyllosomes et la post-larve de *Scyllarides squamosus* (H. Milne-Edwards) – Scyllaridae (crustaces decapodes). *Cah. O. R. S. T. O. M.*, Ser. Oceanogr., *VI*(3-4): 47-53.

MIERS, E. J.

1882. On crustaceans from the Mauritius – Part II. *Proc. Zool. Soc. London*, 1882: 538-543.

MILNE-EDWARDS, A.

1880. Etudes preliminaries sur les crustaces du Blake. *Bull. Mus. Comp. Zool.*, 8: 1-67.

NAKAMURA, H.

1936. The food habits of yellowfin tuna *Neothunnus macropterus* (Schlegel) from the Celebes Sea. *U. S. Fish Wildl. Serv.*, Spec. Sci. Rep. No. 23: 1-8.

NEWMAN, W. A.

1960. *Octolasmis californiana*, spec. nov., a pedunculate barnacle from the gills of the California spiny lobster. *The Veliger 3*(1): 9-10.

NOMURA, H. and J. F. FILHO

1966. Shrimp survey in coastal and offshore waters of northeastern and northern Brazil. *Arq. Est. Biol. Mar. Univ. Fed. Ceara, 6*(1): 15-19.

ORTON, J. H. and E. FORD

1933. The post-puerulus of *Palinurus vulgaris*, Latr. *Proc. Zool. Soc. Lond.*, 1933: 181-188.

PAUL'SON, O.

1875. Studies on crustacea of the Red Sea. Part I: 164 pp.

PFEFFER, G.

1881. Die Panzerkrebse des Hamburger Museums. *Verh. Naturw. Ver. Hamb.*, 5: 22-55.

PRASAD, R. R. and P. R. S. TAMPI

1960. On the newly hatched phyllosoma of *Scyllarus sordidus* (Stimpson). *J. Mar. Biol. Ass. India*, 2: 250-252.

PRASAD, R. R. and P. R. S. TAMPI

1968. Nistos of two species of *Scyllarus*. *J. Mar. Biol. Ass. India, 9*(1): 116-120 (for June, 1967).

PROVENZANO, A. J., JR.

1968. Recent experiments on the laboratory rearing of tropical lobster larvae. *Proc. Gulf Carib. Fish. Inst.* 21st Ann. Sess., Nov. 1968: 152-157.

RAMOS, F. DE P. A.

1951. Nota sobre *Scyllarides brasiliensis* Rathbun e sua ocorrencia no litoral do Estado de Sao Paulo. *Bol. Inst. Paulista Oceanogr., 2*(2): 125-133.

RANDALL, J. E.

1967. Food habits of reef fishes of the West Indies. *Stud. Trop. Oceanogr.* No. 5: 665-847.

RATHBUN, M. J.

1900. The decapod crustaceans of West Africa. *Proc. U. S. Nat. Mus. XXII* (1199): 271-316.

RATHBUN, M. J.

1901. The Brachyura and Macrura of Porto Rico. *Bull U.S. Fish. Comm., 20* (for 1900, 2) 1-127.

RATHBUN, M. J.

1902. Papers from the Hopkins Stanford Galapagos Expedition, 1898-1899. 8. Brachyura and Macrura. *Proc. Wash. Acad. Sci.*, 4: 275-292.

RATHBUN, M. J.

1906a. The Brachyura and Macrura of Porto Rico. *Bull U.S. Fish. Comm.*, 20 (for 1900) (2): 1-127.

RATHBUN, M. J.

1906b. A new *Scyllarides* from Brazil. *Proc. Biol. Soc. Wash.*, 19: 113.

RATHBUN, M. J.

1935. Fossil crustacea of the Atlantic and Gulf coastal plain. *Geol. Soc. Amer.*, Spec. Paper No. 2: 1-160.

ROBERTSON, P. B.

1968a. The larval development of some western Atlantic lobsters of the family Scyllaridae. Thesis, June 1968, Univ. Miami: 513 pp.

ROBERTSON, P. B.

1968b. The complete larval development of the sand lobster, *Scyllarus americanus* (Smith), (Decapoda, Scyllaridae) in the laboratory, with notes on larvae from the plankton. *Bull. Mar. Sci.*, *18*(2): 294-342.

ROBERTSON, P. B.

1968c. A giant scyllarid phyllosoma larva from the Caribbean Sea, with notes on smaller specimens (Palinuridea). *Crustaceana*, Suppl. 2 (Studies on decapod larval development): 83-97.

ROBINSON, R. K. and D. E. DIMITROU

1963a. The status of the Florida spiny lobster fishery, 1962-1963. *Fla. Bd. Conserv.*, Tech. Ser. No. 42: 1-30.

ROBINSON, R. K. and D. E. DIMITROU

1963b. Length frequencies of adults of *Panulirus argus* and occurrence of phyllosoma larvae in south Florida. Rep. Inst. Mar. Sci. Univ. of Miami to Fla. Bd. Conserv. Mimeo.

SAISHO, T.

1962. Notes on the early development of a scyllarid lobster, *Parribacus antarcticus* (Lund). *Mem. Fac. Fish. Kagoshima Univ.*, *11*(2): 174-178.

SAISHO, T.

1966. Studies on the phyllosoma larvae with reference to the oceanographical conditions. *Mem. Fac. Fish. Kagoshima Univ. 15:* 177-239.

SAISHO, T. and NAKAHARA, K.

1960. On the early development of phyllosomas of *Ibacus ciliatus* (von Siebold) and *Panulirus longipes* (A. Milne Edwards). *Mem. Fac. Fish. Kagoshima Univ.*, *9:* 84-90.

SANTUCCI, R.

1925. Contributo allo studio dello sviluppo post-embrionale degli "Scyllaridea" del Mediterraneo. 2. *Scyllarus arctus* (L). 3. *Scyllarides latus* Latr. *R. Comit. Talassogr. Ital.*, Mem. 121: 16 pp.

SCHMITT, W. L.

1924. Report on the Macrura, Anomura, and Stomatopoda collected by the Barbados-Antigua Expedition from the University of Iowa in 1918. *Nat. Hist. Ia. Univ.*, *10*(4): 65-99.

SCHMITT, W. L.

1935. Crustacea Macrura and Anomura of Porto Rico and the Virgin Islands. Scientific survey of Porto Rico and the Virgin Islands. *New York Acad. Sci.*, *15*(2): 125-227.

SCHROEDER, R. E.

1965. Something Rich and Strange. Harper & Row, New York. 185 pp.

SCHROEDER, R. E. and W. A. STARCK, II

1964. Diving at night on a coral reef. *Jour. Nat. Geog. Soc., 125*(1): 128-154.

SHEARD, K.

1949. The marine crayfishes (spiny lobsters) family Palinuridae of western Australia with particular reference to the fishery on the western Australian crayfish (*Panulirus longipes*). *Commonwealth Scient. Indust. Org., Australia,* Bull. No. 247: 1-45.

SIMS, H. W., JR.

1964. Four giant scyllarid phyllosoma larvae from the Florida Straits with notes on smaller similar specimens. *Crustaceana, 7*(4): 259-266.

SIMS, H. W., JR.

1965. The phyllosoma larvae of *Parribacus. Quart. Jour. Florida Acad. Sci., 28*(2): 142-172.

SIMS, H. W., JR.

1966a. An annotated bibliography of the spiny lobsters, families Palinuridae and Scyllaridae. *Fla. Bd. Conserv. Mar. Lab.*, Tech. Ser. No. 48: 1-84.

SIMS, H. W., JR.

1966b. Notes on the newly hatched phyllosoma of the sand lobster *Scyllarus americanus* (Smith). *Crustaceana, 11*(3): 288-290.

SIMS, H. W., JR.

1968. Notes on spiny lobster larvae in the north Atlantic. *Quart. Jour. Florida Acad. Sci., 29*(4): 257-264.

SIMS, H. W., JR. and C. L. BROWN, JR.

1967. A giant phyllosoma (spiny lobster) larva taken north of Bermuda. *Navy Underwater Sound Lab.*, Rpt. No. 853: 1-6.

SIMS, H. W., JR. and R. M. INGLE

1966. Caribbean recruitment of Florida's spiny lobster population. *Quart. Jour. Florida Acad. Sci., 29*(3): 207-242.

SMITH, F. G. W.

1958. The spiny lobster industry of Florida. *Fla. Bd. Conserv.*, Ed. Ser. No. 11: 1-36.

SMITH, S. I.

1869. Descriptions of a new genus and two new species of Scyllaridae and a new species of *Aethra* from North America. *Am. Jour. Sci., 48*(142): 118-121.

SMITH, S. I.

1881. Preliminary notice of the Crustacea dredged, in 64 to 325 fathoms, off the south coast of New England, by the United States Fish Commission in 1880. *Proc. U. S. Nat. Mus.*, 3: 429-431.

SPRINGER, S. and H. R. BULLIS, Jr.

1956. Collections by the *Oregon* in the Gulf of Mexico. *U. S. Fish Wildl. Serv.* Spec. Sci. Rep. No. 196: 1-134.

STEPHENSEN, K.

1923. Decapoda-Macrura excl. Sergestidae. *Rep. Danish Oceanogr. Exped. Medit., 2*(3): 1-85.

STIMPSON, W.

1866. Descriptions of new genera and species of macrurous crustacea from the coasts of North America. *Proc. Chicago Acad. Sci.*, 1: 46-48(?). (Portion of plates and text of Vol. 1 destroyed by fire before publication, never reset.)

STIMPSON, W.

1871. Notes on North American crustacea in the Museum of the Smithsonian Institution. No. 3. *Ann. Lyceum Nat. Hist. N. Y., 10*(1974): 92-136, 119-163.

SWEAT, D. E.

1968. Growth and tagging studies on *Panulirus argus* (Latreille) in the Florida Keys. *Fla. Bd. Conserv. Mar. Lab.*, Tech. Ser. No. 57: 1-30.

TABB, D. C. and R. B. MANNING

1961. A checklist of the flora and fauna of northern Florida Bay and adjacent brackish waters of the Florida mainland collected during the period July, 1957 through September, 1960. *Bull. Mar. Sci. Gulf Carib., 11*(4): 552-649.

VERRILL, A. E.

1922. Decapod crustacea of Bermuda. Pt. 2. Macrura. *Trans. Conn. Acad. Arts. Sci.*, 26: 1-179.

WILLIAMS, A. B.

1965. Marine decapod crustaceans of the Carolinas. *U. S. Fish Wildl. Serv.*, Fish. Bull., *65*(1): 1-298.

WITHAM, R., R. M. INGLE, and E. A. JOYCE, Jr.

1968. Physiological and ecological studies of *Panulirus argus* from the St. Lucie estuary. *Fla. Bd. Conserv. Mar. Lab.*, Tech. Ser. No. 53: 1-31.

WITHAM, R., R. M. INGLE, and H. W. SIMS

1964. Notes on postlarvae of *Panulirus argus. Quart. Jour. Florida Acad. Sci., 27*(4): 289-297.